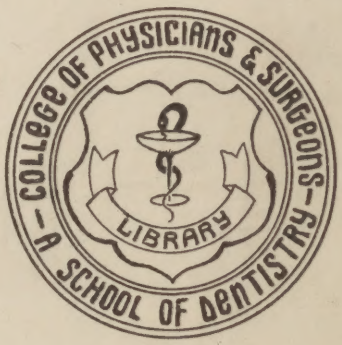
HAND-BOOKS
FOR
PHYSICIANS

SEWELL



HANDBOOK

OF

DENTAL ANATOMY

AND

SURGERY.

BY

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PREFACE.

No department of physiology or surgery has of late years made greater progress than that connected with the teeth, and this advance has been necessarily attended by a corresponding increase in the literature of the subject, which has now become so voluminous as to form a source of embarrassment to those who are entering upon a course of dental education. Under these circumstances the projectors of the "Student's Guide" manuals have considered a work on Dental Anatomy and Surgery a desirable addition to the series. It is designed that these manuals should be free from needless technicalities; that they should facilitate the labors of the student; and that whilst each volume—although presenting merely an outline of the subject—should be complete in itself, it should at the same time lead the reader to desire, and direct him in seeking, the fuller knowledge afforded by more extended treatises. These designs I have striven to accomplish in this volume.

It must, however, not be supposed that the student can profitably peruse even the most rudimentary text-

book on any special branch of physiology or surgery without an adequate knowledge of the fundamental principles of those sciences; and evidently it can but confuse him to encounter such terms as "nucleus" and "cell," or "inflammation" and "abscess," unless he have a clear conception of their signification. Such knowledge must be obtained previously from elementary works on physiology and surgery.

Whilst in a work of this kind it is essential that, as far as practicable, facts only should be laid before the student, it is not possible to avoid altogether the discussion of controverted points, or at least the description of subjects that have as yet been insufficiently investigated. Among these subjects must be placed the development of the teeth. The description of this process which is found in physiological text-books, even the latest editions, is entirely based upon the investigations of Goodsir, which were published by him in the *Edinburgh Medical and Surgical Journal*, in the year 1838. Since that date the subject has been investigated by numerous physiologists, among whom may be specially mentioned Marcusen, Dursy, Kölliker, and Waldeyer, and they are agreed with regard to the main facts of the process. Aided by the advance of microscopical science since the time of Goodsir, they have traced the phenomena of dental evolution from a period of embryonic life much earlier than that at which it was supposed to commence by that renowned physiologist, and have thus necessarily overthrown much of his theory.

Messrs. Legros and Magitot have issued the latest monograph on the subject—a most elaborate and minute description, entirely based upon original observations—and the corroboration it receives from previous investigations, leaves no doubt that it is substantially accurate. The section which I have in this manual devoted to the developement of the teeth is merely a summary of the work of these physiologists.

The histogenesis of the dental tissues—the changes which take place in the tooth-germ by which its elements are gradually converted into these tissues—has been, like the preceding subject, investigated by numerous physiologists, and like it has given rise to considerable difference of opinion. The majority of more recent observers (Lent, Kölliker, Marcusen, Huxley, Robin, Magitot, Tomes, and Waldeyer) are, however, in accord with regard to essential points, and in the account which I have given I have attempted to epitomize the main facts elucidated by these authorities without entering upon controverted topics.

The theory of the etiology and pathology of caries which I have adopted, is entirely based upon generally admitted facts; it is that which I believe can alone be arrived at by reasoning upon such facts; it is that which recently has been enunciated by the best authorities, and eventually must be, in my opinion, universally accepted. It will be perceived that decay of the teeth is a process entirely dissimilar to caries of bone, and that although the

term caries is retained for the sake of convenience, it is not really indicative of the true character of the disease.

No more than passing reference has been made to those injuries and diseases of the mouth and jaws that are not intimately associated with dental pathology. Although these affections necessarily fall much under the notice of the dental surgeon, who is therefore required to possess a knowledge of their nature, their discussion belongs more properly to works on general surgery than to those devoted entirely to dental subjects.

A knowledge having been obtained of the principles upon which operative procedures are carried out, and of the materials and instruments employed, the student cannot commence too soon to acquire skill by practice and experiment. This practice is easily obtained by the dental student. He may begin by plugging with tinfoil cavities cut in bone or ivory or in extracted teeth, each stopping after completion being carefully broken up to discover in what detail it has failed, or in what direction it is capable of improvement. In the same way such operations as capping the pulp and fang-filling may also be practiced. As soon as the student can with rapidity and certainty fill difficult cavities in extracted teeth fixed in a vice, he may safely proceed to operate upon simple cavities in the mouth of the living subject. Similar remarks may be made with regard to the operation of extraction. The anatomy of the teeth and of the parts around being understood, the student may proceed to

apply the forceps to the different kinds of teeth, and familiarize himself with the mode in which the instrument is held, the tooth grasped, and the force applied. Every student should subsequently go through a course of extracting operations on the dead subject, opportunities for which are afforded at every school of medicine.

Of the illustrations some are original, some are copied, and some are borrowed from works the property of the publishers. Those illustrating the development of the teeth are copied from Messrs. Legros and Magitot's monograph. For some of the most valuable I am indebted to the admirable works of Messrs. Tomes, Mr. Christopher Heath, and Mr. Salter. Figs. 33, 35, and Figs. 73 to 77 are taken by permission from the *Transactions of the Odontological Society*. Among the original engravings, those in the sections on preparing cavities and gold filling, have been most kindly contributed by my friend Mr. Howard Mummery. The cuts of the instruments have been supplied by the eminent and well-known firm of Ash & Sons, of 7 Broad Street, Golden Square.

6 Wimpole Street, W.,
Feb. 1876.

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LIST OF AUTHORS.

1. Waldeyer, . . Structure and Development of the Teeth. Stricker's Histology.
2. Legros and Magitot, Origine du Follicule Dentaire-Journal de l'Anatomie, 1873.
3. Wedl, . . . Pathology of the Teeth.
4. Tomes, J. & C. S., System of Dental Surgery.
5. Tomes, Charles S., The Attachment of Teeth. Trans. Odont. Soc. Vol. VII. New Series.
6. Tomes, Charles S., Nasmyth's Membrane. Journal of Microscopical Science, 1872.
7. Salter, . . . Dental Pathology and Surgery.
8. Magitot, . . . Traité de la Carie Dentaire.
9. Heath, . . . Injuries and Diseases of the Jaws.
10. Mason, . . . Irregularities of the Teeth. Trans. Odont. Soc. Vol. V. New Series.
11. Cattlin, . . . Accidents in Dental Surgery. Trans. Odont. Soc. New Series.
12. Sewill, . . . Irregularities of the Teeth. Lancet, 1870.
13. Sewill, . . . Papers on Dental Surgery. Dental Journal, 1868–72.
14. Sewill, . . . Irregularities and Diseases of the Teeth.
15. Sewill, . . . Absolute Alcohol in Dental Operations. Trans. Odont. Soc. Vol. VII. New Series.

THE

STUDENT'S GUIDE

TO

DENTAL ANATOMY AND SURGERY.

ANATOMY AND HISTOLOGY OF THE TEETH.

Human teeth are hard structures of a bony character, implanted in the alveoli along the margins of the jaws for the purpose of triturating the food preparatory to its passage into the stomach, and solution by the gastric juice. Two sets of teeth are developed during life —the first, the temporary, deciduous, or milk teeth, ten in each jaw, and the second or permanent teeth, sixteen in each jaw.

The teeth are divided into classes according to their function and external configuration, but they have all certain characters in common. Every tooth consists of *a crown*, the portion which appears above the gum, *a root* or roots imbedded in the jaw, and *a neck*, the portion which unites the crown and root, and which is surrounded by the free edge of the gum.

The permanent set is made up of four incisors, formed

for cutting, two canines for cutting and tearing, and four bicuspids and six molars for grinding the food.

The upper incisors have chisel-shaped crowns, the front surface convex, the back concave. Viewed laterally the crown is wedge-shaped, the base of the wedge being at the gum, the apex at the cutting edge. The cutting edge is horizontal, its distal angle being rounded, its mesial acute. Before becoming worn by mastication the edge is marked by three small tubercles, which give it a serrated appearance. The root is single, conical, and slightly compressed laterally. The central are about one-third larger than the lateral incisors.

The lower incisors are similar in shape to the upper, but they are smaller, the root is more flattened at the sides, both angles of the cutting edge are acute, and unlike the upper teeth the central is less in size than the lateral.

The canines, or eye teeth, are stronger than the incisors, to which they bear a general resemblance. The crown is convex anteriorly, concave posteriorly, and may be compared to that of an incisor with the angles bevelled off, and terminating in a sharp central cusp. These teeth have one root which is stronger and longer than any other of the set. It is conical in shape and slightly more flattened laterally than that of an incisor.

The lower canines are smaller than the corresponding upper teeth, the cusp is more obtuse, the root more flattened at the sides.

The upper bicuspids viewed from the front, bear a close resemblance to the canines, than which however they are smaller. The crown springs vertically from the neck, its labial and lingual aspects being convex, its mesial and distal surfaces somewhat flattened. Its long diameter is across the jaw. The masticating surface is

divided by a deep antero-posterior groove into two cusps, of which the inner is the smaller. The root is conical, and more compressed laterally than that of either the incisor or canine. It is deeply grooved and often bifid, the cleft occasionally dividing the root throughout the greater part of its length.

The lower bicuspids are smaller than the upper, the internal cusp is less well marked, and the root is much compressed, but rarely bifid.

The molars have crowns of a cube-like form, the labial and lingual aspect rounded, the mesial and distal flattened. The grinding surface is divided by grooves into tubercles or cusps. The neck is rounded and well-defined. The molars of each jaw decrease in size from before backwards.

The masticating surface of an upper molar has four cusps, one at each angle, but in the third molar or wisdom tooth the internal cusps are blended into one mass. The first and second upper molars have three conical roots, two external spreading apart upwards towards the antrum, and one, the smallest, directed towards the palate. The latter is occasionally bifid. The root of the wisdom tooth is, as a rule, single, forming an irregular conical mass, which is often either deeply grooved or shows traces of subdivision into three roots. The crowns of the lower molars are a little larger than those of the upper jaw, and they are surmounted by five cusps, one at each angle, and the fifth between the two posterior cusps. The first and second lower molars have each two roots, one anterior and one posterior. They are broad, compressed, and grooved on the surfaces turned towards each other, and they have an inclination slightly backwards in the jaw. The root of the lower wisdom

tooth, like that of the upper, is often connate, but occasionally it is bifid or divided into two distinct fangs.

The entire set of teeth in each jaw are arranged in an elliptical curve, the incisors, canines, and bicuspids forming an almost perfect semicircle, the molars and bicuspids continuing the lines backwards. The lower teeth are placed vertically in front and looking somewhat inwards at the sides and behind, whilst the corresponding upper teeth have an inclination forwards in front and outwards behind, so that the upper teeth slightly overhang the lower. In consequence of this arrangement and the difference in size between the teeth of the two jaws, each upper tooth on closure of the jaws, impinges partly on the corresponding lower tooth and partly on the tooth next following; but the upper dental arch being larger than the lower, and the upper molars being smaller than those of the lower jaw, the upper wisdom teeth do not extend backwards beyond the range of the lower teeth.

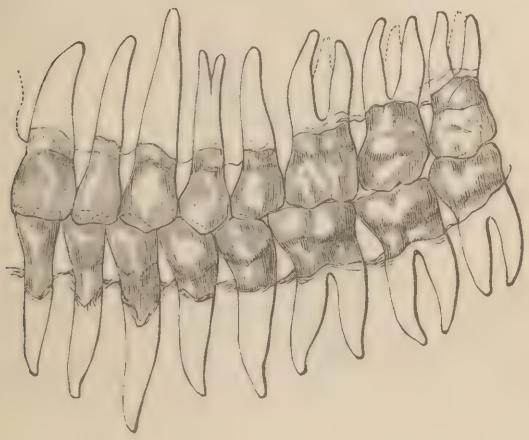
The teeth are fixed in position by the implantation of their roots in the alveoli of the jaws, the bone, lined with periosteum, investing and accurately fitting them and providing a separate socket for each root. This form of articulation has been termed *gomphosis*, from the resemblance to the impaction of a nail driven into wood.

The annexed diagram from Wedl (3) (Fig. 1), shows at one view the form and character of a normal set of teeth, the direction and arrangement of the roots within the bone, and the relation of the upper and lower sets to each other when closed.

The temporary teeth resemble the permanent set, but are considerably smaller. There are no bicuspids in this set. It is made up of four incisors, two canines,

and four molars. The first upper molar is smaller than the second, and has three cusps, two external, one internal. The second upper molar has four cusps. The first lower molar is smaller than the second, and has

Fig. 1.



four cusps. The second lower molar has five cusps, three external, two internal. The roots of the temporary set are similar to those of the corresponding permanent teeth. The fangs of the molars are, however, more divergent from the neck of the tooth, and are hollowed on their inner aspect to afford space for the crypts of the developing bicuspids situated beneath them.

On section (Fig. 2), each tooth is seen to be composed of three tissues, distinct in structure but intimately united with each other, the enamel which covers the crown, the cement which coats the roots, and the dentine which forms the great bulk of the organ. When the teeth first make their appearance the enamel is covered

by a thin layer of peculiar tissue, the cuticula dentis or Nasmyth's membrane, which however becomes soon worn off by mastication. In the centre of the tooth is the pulp-cavity, a chamber similar in shape to the external outline of the tooth, and containing a vascular and ner-

Fig. 2.

Vertical section of a molar tooth (Huxley).
a. Enamel. *b*. Pulp-cavity. *c*. Cement. *d*. Dentine.

vous structure, the dental pulp. The vessels and nerves of the pulp enter the chamber through foramina in the apices of the roots.

The enamel forms a cap or layer adapted to the surface of the dentine. It attains its greatest thickness on the cutting edges and summits of the masticating surface of the teeth, whence gradually decreasing, it slopes towards the neck and terminates beneath the free edge of the gum, where it is slightly overlapped by the cement. It is an extremely hard translucent substance, either of a yellowish or of a bluish-white color. It is the hardest tissue of the body, ranking in density with limpid quartz, and emitting a spark when struck with steel.

It contains not more than from one to three per cent. of organic matter, ninety per cent. of calcium phosphate with a trace of fluorine, and four to five per cent. of calcium carbonate, the remainder being made up of traces of magnesium phosphate and other salts. It is entirely soluble in acids, leaving but the smallest trace of organic matter. Enamel is devoid of sensibility.

Examined microscopically enamel is found to consist of solid fibres or prisms mostly hexagonal, but some nearly square, others nearly circular (Fig. 3), lying par-

Fig. 3.

Enamel fibres, viewed in transverse section.

allel side by side without any intermediate substance. These fibres spring from depressions on the surface of the dentine, and radiate outwards in an undulating course towards the exterior of the tooth, so that their direction varies between vertical at the masticating surface and horizontal at the sides. Most of the fibres extend through the whole thickness of the tissue; and although they cannot be demonstrated, there must exist, probably, shorter fibres to fill up the intervals which would otherwise exist in consequence of the divergence of the longer prisms in their outward course. The diameter of the prisms is about $\frac{1}{5500}$ of an inch. They are mostly marked at short regular intervals by transverse striæ, so

that each fibre resembles a sheath containing a line of granular masses, but this condition is not very visible in young and in dense well-formed tissue. The prisms (Fig. 4) also show at intervals slight bulgings or varicosities. No generally accepted explanation of the origin of the striæ and varicosities has yet been made. They perhaps constitute the remaining trace or expression of the soft cell elements in which the tissue existed before calcification. The decussation of the prisms, a peculiar pattern exhibited by enamel in section beneath the microscope, is only apparent, not real. The tissue is made up of many layers, the fibres in each layer being parallel, but the direction pursued by fibres of different layers varying considerably. The appearance of decussation is visible only under a high magnifying power, in a thin section which is made up of several layers of prisms, and which is of course transparent. Hence the crossing of fibres, which actually lie on different planes, gives rise to the apparent free decussation of prisms lying on the same plane.

Fig. 4.

Enamel prisms separated and viewed laterally.

Dentine or ivory forms the great bulk of the tooth, and incloses the central cavity. It is a yellowish-white elastic tissue, presenting a finely fibrous fracture, and intermediate in hardness between enamel and dense bone, which latter it resembles somewhat in its general aspect and chemical characteristics. It contains twenty-eight per cent. of animal and seventy-two of earthy matter. Treated with acids the earthy constituents are dissolved, and there remains a material called dentinal cartilage,

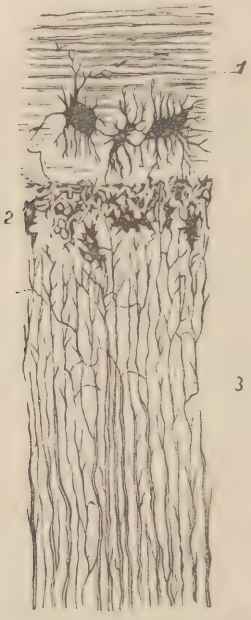
which retains the form of the tooth, and which is precisely similar to ossein, the animal basis of ordinary bone tissue. The seventy-two per cent. of earthy constituents are made up of 64 parts of calcium phosphate, 5 of calcium carbonate, and 3 of magnesium phosphate and other salts, with a trace of fluorine.

Examined microscopically (Fig. 5), dentine is found to consist of innumerable minute tubes having distinct walls, and running close together through an intermediate substance—the intertubular substance or matrix. Commencing by open orifices on the walls of the pulp-cavity, the tubes radiate outwards in an undulating course, giving off numerous branches, which freely anastomose. In the upper part of the crown they have a vertical direction, towards the sides they become oblique, then horizontal, finally inclined downwards towards the point of the root. Each tube, as a rule, extends throughout the whole thickness of the tissue. Their diameter is about $\frac{1}{3\,5\,0\,0}$ of an inch, the inner ends being larger than at a distance from the pulp-cavity. The distance between adjacent tubes is about two or three times their width. The tubes and their branches are occupied by soft fibrils which anastomose. These fibrils proceeding from the central pulp are probably elongated processes of the odontoblasts, the special cells of the pulp. The inner walls of the tubes surrounding the fibrils constitute the dentinal sheaths. These sheaths are apparently of fibrous structure, but are believed by some observers to be calcified. They can be demonstrated most clearly after removal of the fibres by maceration, and they remain as a white fibrous felt even after boiling in strong muriatic acid, or in caustic alkalies.

The dentinal tubes terminate in the crown by fine

processes, which either anastomose or become extremely minute, and are lost beneath the enamel, into which tissue, however, a few may penetrate. In the root they

Fig. 5.



Transverse section of the root of a canine tooth.
1. Cement. 2. Granular layer. 3. Dentine.

end beneath the cement, by opening into the irregular spaces of the granular layer.

The intertubular substance or matrix is translucent and finely granular, resembling compact bony tissue. It contains the greater part of the earthy constituents of the dentine.

The granular layer of the root (Fig. 5), which exists

between the dentine and cement, may be said to constitute the line of transition where these tissues blend. The layer is made up of granules or minute globules, and contains numerous spaces apparently due to imperfect coalescence of these elements. Into these spaces (as above mentioned) the dentinal tubes open, and the spaces are again connected with the lacunæ of the cement by fine canaliculi.

Dentine is endowed with a considerable amount of sensibility, due to the soft fibrils which permeate its tubes, and which, as we have seen, directly emanate from the pulp. It is more sensitive immediately beneath the enamel than deeper, until the pulp-chamber is approached. The sensibility disappears when the death of the pulp takes place.

The cement forms a thin layer, which, commencing at the neck, where it slightly overlaps the enamel, gradually increases towards the apex of the root. It is a true bone structure, having the same chemical and microscopical characters as that tissue. Existing only in a thin layer in man, cement is, however, destitute of Haversian canals. It contains, as a rule, canaliculi throughout, and lacunæ at its thicker parts; but either or both of these may be wanting where the tissue is extremely thin. In the latter case it presents, on section, a perfectly homogeneous appearance.

The cement is invested with periosteum, which is intimately connected with the submucous layer of the gum, and with the periosteum of the alveolar process. It is a delicate connective-tissue membrane, containing abundance of vessels and nerves, which are derived from those of the submucous tissue, from those which

supply the pulp, and from those of the contiguous alveolar wall.

Nasmyth's membrane is an extremely thin homogeneous membranous layer, covering the enamel. It exists only on young teeth which have not been long used in mastication. It resists the action of the strongest mineral acids, but softens when boiled in caustic potash. It is destitute of calcareous matter, the traces found being probably due to adherent particles of enamel. Although other theories as to its nature exist, the majority of authorities are agreed that Nasmyth's membrane is merely a thin layer of cement modified in structure, and exactly corresponding to the thick coronal-cement found on the teeth of herbivorous animals. This theory has lately been confirmed by the investigations of Mr. Charles Tomes (6), who has especially pointed out that coronal cement of well-marked structure, containing lacunæ and canaliculi, occasionally occurs in human teeth, and that when such a layer does not exist, it may be often found that fissures of the enamel are filled with a bone-like tissue continuous with Nasmyth's membrane.

The dental pulp which occupies the central cavity constitutes the remains of the original papilla from which the dentine was developed. It consists of fine fibrous connective tissue, containing numerous cells, and is well supplied with bloodvessels and nerves, which enter the cavity through the small orifices in the apices of the roots. Its external surface, lying in contact with the walls of the pulp-cavity, is made up entirely of a layer of dentinal cells (odontoblasts). These cells have numerous processes, one set of which enter

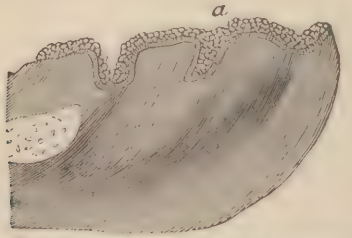
the dentinal tubes and form the fibrils, whilst others unite together contiguous cells.

As age advances, gradual calcification of the pulp takes place, until at last it is reduced to a few fibrous filaments, with the remains of vessels and nerves. The tissue resulting from this calcification is called secondary dentine. In some cases the process commences in the external layer of odontoblasts, and the new-formed tissue coalesces from the first with the previously formed dentine, and the tubes of the two are continuous. In other cases secondary dentine is deposited in isolated nodules scattered through the pulp. These nodules sometimes unite and form larger masses, which again may become attached to the walls of the pulp-cavity. The masses of secondary dentine are occasionally traversed by canals containing bloodvessels, and surrounded by concentric lamellæ, like the Haversian canals of bone. This variety is called osteodentine. At the same time that the slow conversion of the pulp is taking place, the dentinal fibrils also become impregnated with earthy matter and solidified.

THE DEVELOPMENT OF THE TEETH.

The first trace of dental development in man is visible as early as the seventh week of intrauterine life, when the embryo is not more than one inch and a quarter in length. This trace, which can be seen by the naked eye, consists of a smooth oval ridge extending

Fig. 6.



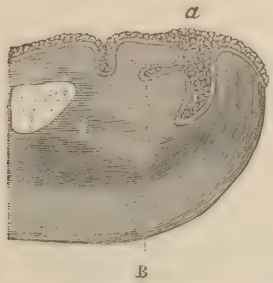
Section of the incisive region of the lower jaw of an embryo sheep, magnified eighty diameters. (The dental development in the sheep and in man are identical.)

a. Epithelial ridge or band which extends the whole length of the maxillary arch, but of which the section only is here visible. From this band the epithelial lamina will be given off later.

along the whole length of the rudimentary alveolar border (*a*, Fig. 6). Section of this ridge shows it to be a continuous vertical band composed of a thick layer of epithelial cells, and it is, in fact, a prolongation of the epithelial layer of the mouth which has sunk into the embryonic tissue of the jaw. Before the end of the eighth week there has become developed, at about the middle of the buried or deep surface of the ridge, a pro-

jection or lamina (B, Fig. 7), which like the layer from which it is derived, extends the whole length of the maxillary border. Its shape is a little flattened from

FIG. 7.



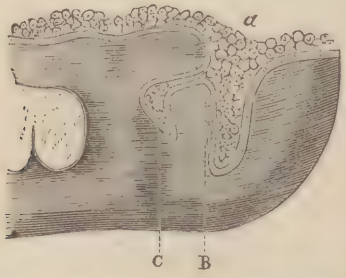
Section of the incisive region of the lower jaw of an embryo sheep, magnified eighty diameters.

a. Epithelial ridge.
B. Epithelial lamina originating from the epithelial ridge.

above downwards, with its extremity rounded and curved in the form of a crook. It is composed externally of columnar cells of the deep or Malpighian layer of the mucous membrane, internally of squamous cells. Within a few more days there can be demonstrated along the border of epithelial lamina in each jaw a series of ten small club-shaped enlargements (C, Fig. 8). These enlargements or buds are the rudimentary enamel organs of the temporary teeth, and they are situated at intervals corresponding to the position of the future teeth. They are composed of the same epithelial elements as make up the lamina, and they are destined by subsequent deposit of calcareous matter to become the external or enamel layer of the crown of the tooth. They remain for some time united to the lamina by a narrow portion

in the form of a neck, which grows longer as the enamel organ increases in size. The enamel organs soon begin to assume the form of the crowns of the future teeth, but at first their shape is not well defined, and resembles

Fig. 8.



Section of the ramus of the lower jaw of an embryo sheep, magnified eighty diameters.

a. Buccal epithelium and epithelial ridge.
B. Epithelial lamina.
C. First appearance of the enamel organ.

a cap with the concavity directed towards the depths of the jaw.

By this time (the ninth week) the first appearance of the dentinal pulp may be detected. This pulp (D, Fig. 9) eventually becomes converted by calcification into the dentine or ivory forming the bulk of the tooth. Its elements first manifest themselves in the depths of the jaw independently of the enamel organ, but directly contiguous to its deeper surface. The pulp at first consists of a small papilla composed of nucleated cells, and penetrated by a vascular loop, and it is, in fact, at this stage merely a special division of the mucous tissue unusually rich in vessels and cells. Later on, when it

has assumed more definite shape, nerve-filaments can be traced into it. It grows until it impinges upon the enamel organ, which becomes moulded upon it like a cap, whilst the papilla gradually assumes the form of the

FIG. 9.

Section of the ramus of the lower jaw of an embryo sheep, magnified eighty diameters.

A. Buccal epithelium.
B. Epithelial lamina.
C. Enamel organ.
D. Dentinal pulp.
E. First appearance of the enamel organ of the permanent tooth.
F. Fibrous tissue whence is derived the dental sac.

crown of the future tooth. Thus, for the incisors it becomes conical, and for the molars develops outgrowths corresponding to the cusps of these teeth.

By the beginning of the fourth month each rudimentary temporary tooth has become enveloped in a distinct closed sac composed of subepithelial connective tissue. This sac begins to appear as soon as the dentinal pulp is slightly advanced in development. An opaque fibrous outgrowth springs from each side of the base of the pulp, and grows towards the summit of the tooth, where it unites with that of the opposite side, and so forms the dental sac. By this time the connection between the

enamel organ and the epithelial process from which it emanated has become severed, owing to resorption of the uniting neck or band of epithelium at the surface of the sac, and this resorption slowly progresses until the whole of the process disappears, leaving the sac completely isolated.

The origin of the permanent set, consisting of sixteen teeth in each jaw, has now to be described. The enamel organs of the ten teeth which replace the temporary set —namely, the incisors, canines, and bicuspids—originate from a bud for each tooth, which is given off from the elongated extremity of the epithelial lamina at its point of junction with the enamel organ of the temporary tooth (E, Figs. 9 and 10).

The enamel organ of the first permanent molar is given off from the posterior extremity of the same epithelial band as gave origin to the temporary tooth. From the epithelial process of this enamel organ a bud springs for the second permanent molar in exactly the same manner as the permanent successors of the temporary set were evolved from the epithelial processes of that set. In a precisely similar fashion the enamel organ of the third molar, or wisdom tooth, arises from the epithelial process of the second molar.

These sixteen germs in each jaw constitute the first traces of the permanent teeth, and they each pass through the same phases of development as we have seen undergone by the germs of the temporary set, these phases being the appearance of the dentinal pulp, its junction with the enamel organ, and their inclosure in the sac. The only further difference to be noted between the development of the permanent and deciduous teeth is in the time which particular teeth take to pass through the

successive stages of evolution. For example, the temporary teeth are usually all cut by the third year, whilst

FIG. 10.

Section of the incisive region of the ramus of the lower jaw of a human embryo. (In this preparation the epithelial cord or process whence is developed the enamel organ of the permanent tooth, is seen partly isolated from its origin in the follicle of the temporary tooth.)

a. Buccal epithelium.
B. Epithelial process or cord of the temporary follicle.
C. Enamel organ.
D. Dentinal pulp covered by a small cap of dentine.
E. Epithelial cord, whence is developed the enamel organ of the permanent tooth.
F. Rudimentary cartilage of the jaw.
G. Section of the dental artery.
H. Traces of ossific matter in the jaw.
I. Section of the dental nerve.

the first permanent molar, although its germ appears at the fifteenth week of fœtal life, is not erupted until the

sixth year. Similar remarks apply to the rest of the permanent set; but it will suffice now to give the dates of the phases of their development so far as above described. The enamel organs of the incisors, canines, and bicuspids make their appearance about the sixteenth week of intrauterine life; those of the first permanent molars about the fifteenth week; those of the second molars about the third month after birth; and those of the wisdom teeth can be demonstrated towards the third year. The dentinal pulps of the ten first-mentioned teeth appear at the twentieth week; those of the first molars at the seventeenth week; those of the second molars about the first year after birth; and those of the wisdom teeth towards the end of the sixth year. The complete closure of the sacs of these teeth is accomplished in the order in which they have been above mentioned at the following dates—9th month, 20th week, 1st year, and 6th year.

The histological changes which take place in the tooth germ by which its elements are gradually converted into the dental tissue, must be now more fully described.

It has been seen that the enamel organ when first formed is composed entirely of epithelial cells—externally of the columnar, internally of the squamous variety. It retains its epithelial nature throughout the process of calcification. This process begins at the surface of the dentine, and progresses outwards. Prior to the deposition of earthy matter the columnar cells immediately in contact with the dentine increase greatly in length, and form six-sided prismatic bodies so arranged as to constitute a columnar epithelium, which, according to Waldeyer, is the most beautiful and regular found in any part of the animal body. This layer is called the

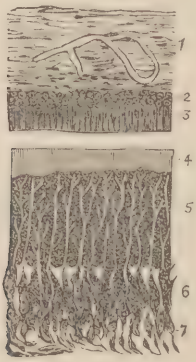
internal epithelium of the enamel organ. The external cells of the enamel organ (termed external epithelium) are shorter and more cubical in form. Numerous vascular papillæ, arising from the contiguous tissue of the dental sac, penetrate to a slight depth the external epithelium, and serve doubtless to provide nutriment to the developing tissue. The cells forming the interior of the organ undergo transformation during the formation of the enamel. At first small and round, they soon become stellate in form, united with each other by their processes, and from the cells of this layer (called stratum intermedium), in contact and united with the internal epithelium, a continuous development of columnar enamel cells proceeds.

It has been stated that the deposition of calcareous matter commences in the enamel organ at the surface of the dentine and proceeds outwards. The completed tissue results from the direct calcification of the internal epithelium. The calcification progresses from the periphery of each cell towards its centre, at the same time uniting together the contiguous columns. Prior to the completion of the enamel the external epithelium and remaining portion of the stratum intermedium undergo atrophy, and it is a question whether these cells ultimately disappear, or take part in forming Nasmyth's membrane (cuticula dentis), the thin layer of peculiar horny tissue which envelops new-formed enamel.

Calcification of the dentinal pulp begins before that of the enamel organ. The process by which the conversion is effected closely resembles the histological formation of bone. It commences at the surface and proceeds inwards, the central portion with the vessels and nerves remaining to constitute the persistent dental pulp or

"nerve" of the tooth. The dentinal pulp (as already mentioned) at first consists of a special division of the rudimentary mucous tissue, rich in vessels and cells. Its fibrous elements consist of a fine connective tissue, through which the cells are scattered. When the pulp has arrived at a certain stage of development the cells begin to be specially organized and arranged. By this time the pulp contains numerous nerve-fibrils besides bloodvessels. The latter form a plexus close to the sur-

FIG. 11.



From Waldeyer (1).

Longitudinal section of a milk-tooth from the fœtal sheep carried through the margin of the dentinal pulp and adjoining portion of the enamel organ, magnified 200 diameters.

1. Dental sac.
2. External epithelium of enamel organ.
3. Internal epithelium of enamel organ.
4. Young layer of enamel detached from the enamel cells.
5. Dentine.
6. Odontoblasts.
7. Part of the dentinal pulp.

face. The specialized cells are termed odontoblasts. They are developed from the cells lying at the periphery,

where they become arranged in a layer so as to form a kind of columnar epithelium. This layer is termed the membrana eboris. The cells are finely granular, have no membrane, and contain a large rounded nucleus. They are each provided with numerous processes, which unite them with the contiguous odontoblasts, and with subjacent developing cells. The nuclei of the odontoblasts disappear, and they become converted into a gelatinous matrix, which undergoes direct calcification, and forms the whole of the hard constituents of the dentine. These changes take place from the periphery of each cell towards the centre. The central portion of each cell remains uncalcified, and forms the soft fibril which occupies the completed dentinal tube. The membrana eboris is constantly fed from the deeper layer of cells, which, united with the odontoblasts by means of their processes, form an uninterrupted series, and provide for the continuity of the dentinal tubes and fibrils. The layer of matrix immediately around the fibrils becomes converted into the dentinal sheaths—the lining walls of the tubes. It has not yet been ascertained whether the sheaths are calcified or not, since their structure cannot be examined except after maceration or incineration of the tissue.

By the end of the seventeenth week of intrauterine life a cap of dentine may be demonstrated on the pulps of all the temporary teeth. By the sixth month the first permanent molar has advanced to a similar stage of development. By the first month after birth the permanent incisors and canines are advanced to the same stage; and at the third year and twelfth year respectively, calcification has commenced in the second molars and wisdom teeth.

The entire crown of each tooth is represented in soft

tissue before the deposition of earthy salts commences, and as the tooth elongates by growth of the pulp from below, successive portions undergo calcification to form the root.

The development of the cement, or crusta petrosa, has not been made out beyond dispute. It probably takes place in a matrix formed by the investing fibrous coat of the dental sac. A special cement pulp has not been demonstrated in man. Cement is, in fact, a thin layer of bone, and the process of its formation is doubtless similar to intramembranous ossification of other bones of the body.

The cuticula dentis (Nasmyth's membrane), already mentioned, is believed by some authorities to be formed from the residuum of the pulp of the enamel after the completion of that tissue. It is, however, much more probable that it is merely a thin layer of modified osseous tissue continuous with the cement, having a similar origin, and analogous to the coronal cement found on the teeth of certain herbivorous animals.

GROWTH OF THE JAWS.

FIRST AND SECOND DENTITION.

Commencing as early as the fifth week of fœtal life, ossification of the maxillary bones proceeds rapidly, and is well advanced at birth. The lateral halves both of the upper and lower jaws at this period are, however, still united by cartilage, and the alveoli of the temporary teeth are represented by a deep trench, divided by incomplete bony plates into large crypts, in which the teeth lie inclosed by the dental sac and submucous tissue. The temporary teeth are represented by their partly calcified crowns, the stage of development varying in the different teeth according to the period at which their eruption is destined to take place. Thus the crowns of the central incisors are nearly complete, whilst the apices alone of the rudimentary crowns of the canines have become converted into a cap of calcified material.

During the first few months after birth, the development of the maxillæ is most active at the surface adjacent to the connecting cartilages and at the alveolar border. The alveoli increase in depth, and by the growth of their free margins overhang and protect the contained teeth. A little later they become nearly closed.

The age at which the eruption of the temporary teeth commences, varies somewhat in different individuals, but it is rarely earlier than the fifth, or later than the ninth month. The eruption of the teeth is a process of

gradual elongation of the teeth on the one hand, and of simultaneous absorption of the superimposed tissues on the other. The absorption commences first in the overhanging margins and front walls of the alveoli, which gradually disappear until room is afforded for the free passage of the advancing tooth. The growth of the tooth keeps pace with this absorption, and the crown at length pressing against its membranous coverings these undergo atrophy, and, becoming by degrees thinner, and at last transparent, give way and disclose the advancing crown.

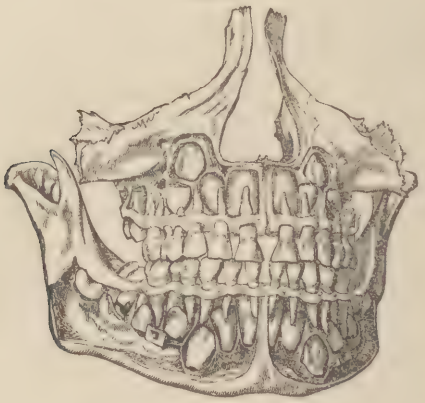
It occasionally happens that these various actions are not perfectly harmonious in their course, the advance of the tooth being more rapid than the disappearance of the inclosing bony and soft tissues. The tooth is thus mechanically held in position, and irritation is set up, which manifests itself by inflammation and induration of the gums, and even by reflex nervous disorders, and constitutional disturbance of various kinds. It is for the relief of such diseases that the operation of lancing the gums of infants is performed. This operation has for its object the division of the abnormally indurated gum, and the release of the advancing tooth. It is obvious that the utility of this procedure must be extremely doubtful when it is carried out prior to the passage of the tooth through the contracted bony orifice of the alveolus; but that it may be reasonably expected to afford relief in cases where the advancing tooth can be distinguished beneath the indurated, tense, and swollen gum.

The order in which the temporary teeth are erupted seldom varies. The lower central incisors are the first which appear. They are followed, after an interval

varying between a week and two or three months, by the corresponding members of the upper set. After another similar lapse of time, the lower quickly followed by the upper lateral incisors present themselves. Next, after like intervals, the first molars, and then the canines are protruded. Lastly, the second molars take their places, and complete the series. By the time that the eruption of the temporary teeth is completed (between the second and third years), considerable progress has been made in the development both of the jaws and permanent teeth. The maxillæ have increased in size, and the fibro-cartilages uniting the lateral halves are completely ossified; the alveoli which had been absorbed to give exit to the teeth have since grown up with the advancing organs, and now closely invest them; the angle of the lower jaw which recently after birth is very obtuse has become more acute, coincident with the development and lengthening of the ramus, and of the articular and coronoid processes. Excepting those of the wisdom teeth, the crowns of the permanent set are all well advanced in calcification, their progress being, however, proportionate to the respective periods of their evolution. The incisors, canines, and bicuspids are completely inclosed in bony crypts. The incisors are situated in the upper jaw above and behind, and in the lower jaw below and behind the roots of the teeth which subsequently they respectively replace. The canines are deeply placed between the crypts of the lateral incisors and first bicuspids. The bicuspids lie within the divergent roots of the temporary molars. The molars, surrounded by incomplete casings of bone, occupy the portion of jaw posterior to the temporary set, extend-

ing into the ramus of the inferior and the tuberosity of the superior maxilla. The anatomy of the jaws at this period, is admirably displayed in Fig. 12, from Mr.

Fig. 12.



Tomes's work (4). It may be noted, that this is the epoch at which the greatest number of teeth are held in the jaws at one time. The whole of the deciduous set, and the whole of the permanent set, are present, and of these the wisdom teeth alone are still totally uncalcified.

Within two years after the completion of the temporary set, a process is commenced by which their roots are gradually removed by resorption, until in time the teeth lose their attachment to the jaws, and are cast off one by one, to be afterwards replaced by the advancing members of the permanent set. The resorption does not begin simultaneously throughout the whole set, but attacks the teeth according to the order in which they

are to be shed. It commences and proceeds, as a rule, at that part of the root towards which the permanent tooth is advancing, but occasionally it affects other parts at the same time. The wasting surface, which on examination is found irregular in outline and broken up into minute pits or depressions, resembles that of bone when undergoing absorption. Closely applied to the whole of this surface there is found a vascular papilla of slight depth, the absorbent organ, the active agent in the removal of the tissues. This papilla consists of a vascular and cellular structure, the portion in contact with the teeth being entirely made up of large multiform nucleated cells. These cells occupy the pits in the wasting tissues. The papilla originates from the contiguous vascular layer of the alveolar periosteum, and it constitutes a special provision in the economy for the removal of the deciduous teeth. Abundant evidence exists that the absorption is not (as was once supposed) due to the pressure of the advancing permanent teeth, and the following are some of the main facts composing this evidence: 1st. In some of the lower animals, notably in the serpent, conditions exist during the evolution of successive sets of teeth, which prove beyond doubt that absorption of deciduous teeth, similar to what occurs in man, may take place independently of pressure. This fact has been recently demonstrated clearly by Mr. Charles Tomes (5). He has pointed out that the succession of teeth in snakes is endless, new teeth continuing to be developed at the inner side of the teeth already in place throughout the lifetime of the animal; that when a tooth is about to be shed, both it and the bone at its base are attacked by absorption, this taking place

at its inner side before the outer side is at all involved, and that the advancing tooth moves forward, the delicate cells of its enamel organ remaining *in situ*, even after absorption has been effected to such an extent that the inner side of the old tooth has been cut away, and the successional tooth has passed into the space thus gained. "It is obvious that if the successional tooth had ever come into contact with its predecessor, these cells, at the point of impact, could not have escaped destruction."

2d. Absorption of a human temporary tooth occasionally goes on at points remote from the permanent successor.

3d. The permanent do not impinge upon the temporary teeth during their advance, and, on the contrary, they are separated from them throughout by the bony walls of the crypts in which they are inclosed.

The process of the eruption of the permanent teeth closely resembles that which has been described as occurring in the first dentition. By the time each temporary tooth is shed, absorption has commenced in the plate of bone which up to this period has closed the crypt of the permanent successor, and this absorption proceeds until the opening is large enough to permit the free passage of the emerging crown. When the crowns of the teeth are fully protruded the development of the alveoli again becomes active, and the bone in time firmly embraces the necks of the teeth, and invests the roots in accurately fitting sockets.

The age at which second dentition commences varies, like the first, in different individuals, but the order in which the teeth appear is rarely irregular. The following may be taken as average dates at which the eruption

of the different teeth is completed. The teeth of each class appear somewhat later in the upper than in the lower jaw:

	YEARS.
First molars, Central inferior incisors,	5 to 7
Central superior incisors,	6 to 8
Lateral incisors,	7 to 9
Anterior bicuspids,	8 to 10
Canines,	9 to 12
Posterior bicuspids,	10 to 12
Second molars,	12 to 14
Wisdom teeth,	17 to 25

The eruption of the permanent teeth is seldom attended with constitutional disorders due to reflex nervous disturbance, such as commonly accompany first dentition; and local irritation is rare, except in the case of the lower wisdom teeth. The protrusion of these teeth is, however, often attended by considerable suffering. They make their appearance after the completion of dentition, at the time when, owing to insufficient backward development of the horizontal ramus of the jaw, crowding of the teeth frequently exists, and the space which should remain for their reception is encroached upon by the second molar. The wisdom teeth in their advance thus become wedged between the posterior surface of the second molar and the coronoid process, and give rise to pressure upon the overhanging mass of gum and mucous membrane. This condition is alone sometimes enough to give rise to considerable swelling and inflammation of the gum, and the mischief becomes aggravated when the opposing teeth of the upper jaw come forcibly in contact with the swollen tissues in mastication. The inflammation spreads to the alveolar

periosteum, and to the uvula, soft palate, and tonsil, and the neighboring lymphatic glands become swelled and painful. The pain is severe, often throbbing in character, and is increased by attempted movements of the jaw and by swallowing. These symptoms are attended with considerable febrile disturbance. If the disease run on suppuration takes place, and an abscess forms and discharges within the mouth, at some point about the swollen gum or adjacent structures. From this time the symptoms may slowly subside, or the inflammation may remain chronic, increasing again into the acute form, from time to time, under the influence of cold or other irritation.

Treatment.—If the teeth of the affected side be sound and the space is too small to allow the full protrusion of the emerging wisdom tooth, it should be at once extracted. This operation should also be performed without hesitation, in order to cut short the patient's suffering, should extensive acute inflammation exist. If the tooth, as sometimes happens, be malplaced, and with the crown so directed as to render it useless in mastication, it should be removed. Under other circumstances the preservation of the tooth may be attempted. Sometimes the necessary space may be obtained by the extraction of the first or second molar, should either of these teeth be extensively decayed. In other cases the excision of the gum covering the tooth will suffice to give relief. The flap of gum should be seized with a dissecting forceps, and cut away with a small bistoury. The mere lancing or division of the gum rarely does much good, as the divided parts fall again at once into contact, and become rapidly united. After the extraction of the tooth or excision of the gum the persistent

application of warm fomentations within the mouth usually soon effects a subsidence of the inflammatory symptoms.

Throughout the entire period of their growth the process by which the maxillæ are moulded into their destined form is similar to that which takes place in all developing bones. It consists, on the one hand, of continuous deposition of bone, and on the other of occasional absorption. It has been already explained how the processes of growth and absorption alternate during the process of dentition and the development of the alveolar border of the jaws. The enlargement of the maxillary arch is produced mainly by deposition of bone upon the facial surface, and as the new layers of bone are deposited absorption takes place upon the lingual surface. In the same way in the development of the posterior portion of the lower jaw, whilst the ascending ramus is increasing in size by the deposition of bone upon the posterior surfaces of the coronoid and the condyloid processes, absorption is going on upon these parts anteriorly, and thus the bones are moulded into their destined form. The deposition of new material is principally subperiosteal, but it also takes place beneath the articular cartilage of the lower jaw, and at the surfaces contiguous to the cartilages which in the infant unite the separate portions of bone in both maxillæ; and the increase in the bulk of the jaws is thus entirely effected, not by interstitial growth or expansion of the bones, but by constant additions to the external surfaces.

Up to a certain period in the growth of the jaws, as previously mentioned, there is not sufficient room in the alveolar arch for the crypts of the developing permanent molars, which, therefore, are inclosed in the base of the

coronoid process of the lower, and in the tuberosity of the upper jaw. The space taken up by the ten anterior permanent teeth almost exactly corresponds to that occupied by the milk teeth, and it is therefore in the backward direction that the required increase in size of the arch takes place. The depth of the bones becomes greater in accordance with the dental and muscular development. Examination of a large series of human maxillæ of different ages, enabled Mr. Tomes to demonstrate the fact, first pointed out by John Hunter, that the growth of the alveolar border, both during the first and second dentition, follows and is dependent upon the growth of the teeth, and that the position of the teeth is not, as was once believed, predetermined by independent growth of the bone. This fact has also lately received confirmation from the observations of Mr. Charles Tomes, upon the mode of attachment of the teeth in fishes and reptiles. He has proved that in the attachment of a tooth by simple anchylosis, or by ever so rudimentary a socket, as it takes place in the varied species, the bone is modelled to the tooth in full subserviency to the position of that tooth, and that the tooth does not come to take its place upon a spot predetermined for it by any disposition of the bone, made prior to its advent.

The portions of bone which give attachment to the muscles of mastication augment in bulk as these organs develop in size and power.

When the teeth are lost from age or other causes, the alveoli waste by absorption; and at the same time mastication being discontinued, the muscles, together with the portions of bone to which they are attached, undergo

atrophy, and the jaws assume the peculiar form characteristic of age.

It happens occasionally that permanent teeth remain imbedded within the jaws instead of making their appearance at the natural epoch of their eruption. It has been just explained, and illustrated in Fig. 12, that at one period in the growth of the maxillæ, before the jaws have attained their full size, enough space for the extended arrangement of the set in an unbroken arch does not exist, and the teeth are therefore crowded within the jaw, the canines and bicuspids being deeply placed, whilst the upper and lower wisdom teeth are situated in the tuberosity of the upper and in the ramus of the lower jaw respectively. If, owing to arrest of development or other cause, the jaws remain unduly small or contracted, enough room for the presence of the entire set of teeth in the dental arch may be always wanting, and some of the set, although fully formed, may continue buried within the bone. This condition, although it may happen in the case of any tooth, most commonly arises, as might be expected, with those teeth —such as wisdom teeth, canines, and bicuspids—which are cut at a late stage of dentition, when the whole available space in an abnormally small maxilla may be taken up by the rest of the set. The eruption of such teeth may be also in the same way prevented by the presence of supernumerary teeth or by persistent temporary teeth holding their position after the time at which they ought to be cast off.

In another class of cases imbedded teeth hold such abnormal positions within the bone that, although room may exist for them in the dental arch, their eruption is impossible. In some of these instances there is evidence

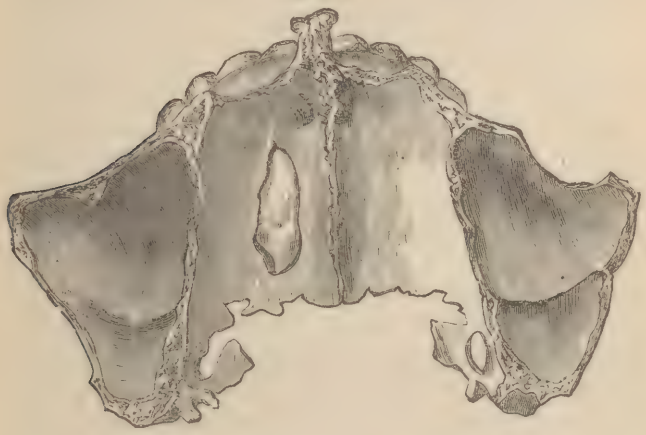
that the malposition is due to deflection of the growing tooth from its normal course by obstacles, such as temporary teeth, or supernumerary teeth, but in others the tooth is situated far from the alveolus, and its misplacement cannot be accounted for. Fig. 13, from Mr. Heath's work (9), shows an upper canine situated

Fig. 13.

within the jaw in a position which it may have possibly assumed in consequence of want of space, whilst Fig. 14 from the same work, exhibits an unaccountable misplacement of an upper canine, which lies horizontally in the floor of the nose, with the crown directed backwards. Imbedded teeth, especially those regularly situated within the bone, sometimes make their appearance after a lapse of time when room is afforded by the

loss of other teeth, and the eruption of such teeth late in life has given rise to the unfounded belief in the occasional occurrence of a third dentition.

Fig. 14.



In the majority of instances, imbedded teeth remain through life, perhaps without the patient being aware of their existence, but in some few individuals they become the centre of cystic disease or of other morbid growths. Such growths connected with teeth are described in a later section.

MALFORMATIONS AND IRREGULARITIES OF THE TEETH.

Dilaceration.—When the mode of development of the teeth is considered, and it is remembered that they are liable to injury at the period when they are but partially calcified, it is easy to understand why teeth are occasionally met with the crowns and roots of which are more or less distorted. In such cases some force—such as a blow—has been transmitted to the developing organ, by which a part or the whole of the crown has become displaced, without severance of its connection with the uncalcified portion of the pulp, and has become subsequently fixed in its malposition by the completion of the process of calcification. This kind of injury has been termed dilaceration. Section of such teeth displays evident marks of the bending which the tissues underwent in the soft state. It is possible that a tooth might be distorted during growth to the extent of dilaceration in consequence of crowding and pressure within the jaw from want of space, and this opinion is strengthened by the fact that the deformity seldom or never occurs except in teeth situated at the front of the jaw where a crowded condition is common.

Teeth which have undergone dilaceration are of course easily recognized when the injury affects the tissues of the crown, but when the crown is well formed and merely bent at an angle with the root, careful examination is sometimes required to distinguish the case from one in

which a well-formed tooth is lying in an abnormal position. The latter case might be amenable to treatment, which would be inapplicable to dilaceration. Teeth the subject of dilaceration often present marked bulgings upon either surface close to the neck, which is frequently constricted and well defined; they occasionally display marked mobility under slight pressure, and the distorted root may be in some cases traced by the finger through the alveolar wall. Fig. 15, from Wedl, represents a case of dilaceration or flexion occurring in an upper central incisor, of which a side view is presented. The crown is perfectly developed, but the root is short and thick and much curved, its apex being directed towards the lips. Fig. 16, from Wedl, shows a lower central incisor the seat of dilaceration, the crown is bent at a right angle to the root, and the cutting edge is directed towards the lips.

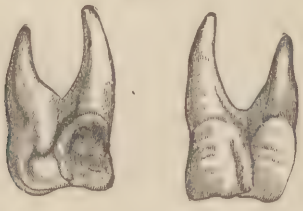
Fig. 15. Fig. 16.

Gemination or organic union of two neighboring teeth sometimes occurs, due to coalescence of contiguous primitive pulps during development. It rarely affects any but incisors, and the union may extend through crown and root, or may affect only a part of the teeth. Blended crowns contain as a rule a common pulp-cavity, but in blended roots the chamber is divided or distinct. Gemination does not necessarily give rise to marked deformity in the appearance of the teeth. Fig. 17, from Tomes, exhibits a lingual and labial view of two incisors of the upper jaw, the crowns of which are thus united.

Supernumerary teeth are frequently met with. They are as a rule easily recognized, being mostly of an irregular conical form, unlike any member of the normal set of

teeth. Their most common situation is towards the front of the mouth, where they are usually placed irregularly among the other teeth. Sometimes a supernumerary tooth is both placed within the dental arch and symmet-

Fig. 17.



rical in form, and hardly distinguishable from its neighbors—an individual in this way possessing an extra or supplemental incisor or canine.

Other abnormal teeth, presenting several forms, varying between so-called warty teeth, studded with nodules of enamel, and monstrous teeth, mere shapeless masses of dental tissue, must be considered identical with the morbid growths termed odontomes, the nature of which will be described in a future section.

The sole treatment available in each variety of the above-described abnormalities is the extraction of the deformed teeth, an operation which may be called for when the faulty tooth is unsightly, or when it is causing displacement of adjoining teeth.

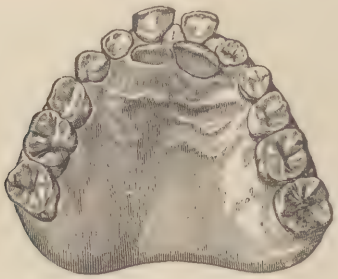
Irregularities of the teeth may be divided into two great classes. 1st. Those in which teeth occupy abnormal positions in well-formed jaws; 2d, those associated with malformation either of the alveolar border or of the body of the jaw.

The first class of irregularities rarely occurs in deciduous teeth, for the reason that in this case the chief cause of irregularity—obstruction by preceding teeth—is absent. Instances of the second class in the infant, although seldom manifest to casual observation, are often perceptible to careful examination, especially when the deformity affects the jaw generally. Irregularities of the temporary teeth, whatever their character, are, however, of little practical importance, since the teeth are shed in early life, and the deformities do not call for treatment.

It was explained in the previous section that, during the process of eruption, the teeth are not closely embraced by bone, and that it is not until some time after the crowns have fully emerged from the wide orifices of the crypts that the alveoli become fully formed, and invest closely the necks and roots of the teeth. During this stage of growth, when the advancing teeth are surrounded by soft, readily yielding tissues only, any slight obstacle to their progress suffices to divert them from their proper direction, and to retain them in a wrong position. The most frequent of such obstacles consist of temporary teeth, or decayed portions of temporary teeth, which have retained their places, after the time at which they ought to have been cast off. The most common example of this kind of irregularity, is illustrated in Fig. 18 (Tomes), where the permanent incisors of the upper jaw are seen to occupy a posterior position, owing to the persistence of the temporary teeth. A corresponding irregularity occurring in the lower jaw, is shown in Fig. 19. By similar causes teeth may be twisted upon their axes, crowded together so as to overlap, or displaced in almost any direction. In such cases if the temporary teeth be extracted sufficiently early, those that are displaced tend

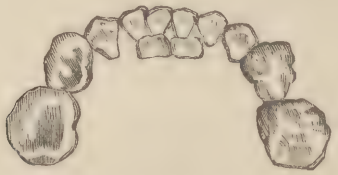
spontaneously to assume their proper positions; but should the deformity be allowed to continue for any great length of time, the teeth become fixed, either by the consolidation of the bone of the jaw, by the advance of the

Fig. 18.



contiguous teeth, or by the locking together of the upper and lower sets when closed. For example, the prompt extraction of the temporary teeth in the case depicted in Fig. 18, would enable nature to effect a cure; but if the

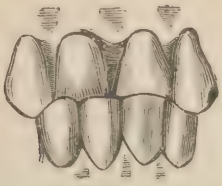
Fig. 19.



operation were delayed until the permanent teeth were fully protruded they would pass, as seen in Fig. 20, on closure of the jaws, behind instead of in front of the lower incisors, and an impediment to their forward movement would be thus constantly opposed. This impediment could then be overcome only by the mechanical

means to be presently described. Similar remarks apply to the corresponding irregularity of the lower teeth. Delay here is, however, not so dangerous as in the case of the upper set. The normal position of the lower

Fig. 20.



front teeth being behind those of the upper jaw the danger of locking does not exist; and after the extraction of the temporary teeth mechanical treatment is rarely required. This operation nevertheless should not be too long delayed, lest the adjoining teeth, taking a forward position, prevent the advance of those that are displaced.

Other causes of the class of irregularities at present under consideration are to be found in injuries, such as blows upon the mouth, the presence of supernumerary teeth, or constant pressure, such as is kept up in thumb-sucking—a habit sometimes acquired by children. Then again, alveolar abscess connected with a temporary tooth may cause displacement of the developing permanent successor; whilst lastly, some cases of simple displacement of one or more teeth alone, in well-formed jaws, can be traced to hereditary predisposition, or to other causes acting prior to the eruption of the teeth.

Fig. 21, from Wedl, exemplifies the form of displacement of the upper front teeth, produced partly by the

persistence of temporary teeth, and partly by the presence of a supernumerary tooth. The supernumerary tooth (*a*) presented itself within the dental arch upon the right side, adjacent to the left central incisor, and thus caused a displacement of the right central incisor (*b*) upwards and forwards. The lateral incisor (*c*) is

Fig. 21.

twisted on its axis, and the permanent canine (*e*) pushed somewhat outwards, in consequence of the retention of the temporary canine (*d*).

It is of course not necessary to describe in detail all the varieties of displacement of teeth of the kind under discussion. The preliminary treatment of them all is the same—namely, the prompt removal, when possible, of the cause.

And it may be here remarked, that whilst uncalled-for interference should be guarded against, there need be no hesitation in extracting temporary teeth, the removal of which is necessary for the cure of irregularities. It is a somewhat popular belief, that the premature extraction of these teeth may act as a cause of subsequent contraction of the jaw, and thus of irregularity of the teeth. This belief is refuted by physiological fact, as well as by practical experience. The

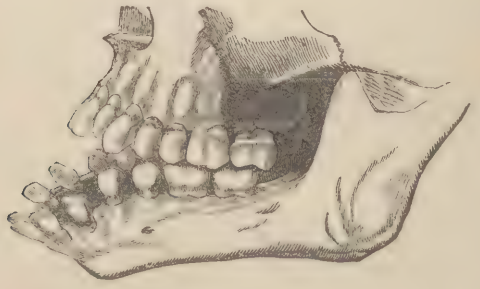
growth of the alveoli of the permanent teeth (as pointed out on a previous page) goes on quite independently of the temporary set; and cases are on record in which, even after the premature loss of the entire temporary set, the jaw attained its normal development, and the permanent teeth assumed their proper positions.

With a knowledge of the order in which the teeth are erupted, and of the characteristics which distinguish the permanent from the temporary set, the mistake of extracting one of the former instead of one of the latter, is not likely to occur. An error of this kind is, however, hardly possible, except in the case of the incisors and canines. The permanent molars may be known from their position posterior to the temporary teeth; whilst the bicuspids may be easily recognized, since no such tooth exists in the deciduous set. The permanent, if present during the persistence of the temporary, incisors, will be found posterior to the teeth which they replace, and their cutting edges are serrated, whilst those of the temporary set by this time are worn smooth. The permanent canines may be distinguished by their great size in comparison with the corresponding temporary teeth, and by their position, which is external and prominent, the root being perceptible as a vertical projecting ridge on the external alveolar wall.

Irregularities, due to malformations of the alveoli or of the body of the jaws themselves, have now to be described. It has been before stated that the normal dental arch is semi-elliptical in shape. The front portion of the figure, containing the incisors, canines, and bicuspids, forms an almost perfect semicircle; whilst the portions containing the molars continue the line backwards at each side. Flattening or contraction of this

arch, or abnormal development of any part of it, necessarily give rise to irregularities of the teeth. This class of irregularities is most commonly congenital, and at the same time often hereditary, a peculiar abnormality in the form of the jaws being in this manner sometimes reproduced in many members of a large family. They may, however, be due to injury or other accidental causes. The deformity may exist in one or both maxillæ, or may be confined to one side only of the bone. The almost marvellous manner in which the jaws (like other bones) may be modified in shape, especially during early life, by the continued application of force in one direction, is not uncommonly exemplified in surgical cases. The sequel of extensive burns of the neck occasionally furnishes a striking instance in point. The cicatrice resulting from such an injury has a constant

Fig. 22.



tendency to contract, and unceasingly drawing the chin towards the chest, causes the body of the jaw gradually to curve downwards. In cases from time to time met with, the curvature is so great that the alveoli are completely everted, and the teeth directed outwards, or even

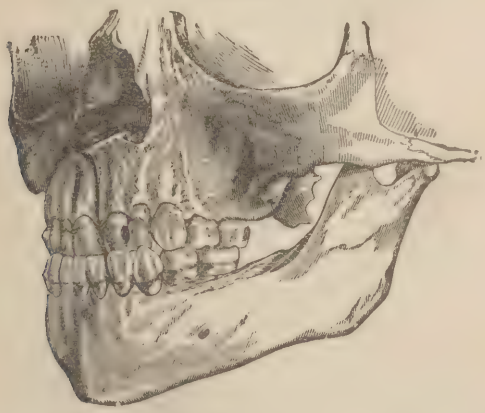
downwards. One of these cases is figured in the annexed engraving (Fig. 22), taken from Mr. Tomes's work.

The nature of these irregularities, associated with

Fig. 23.

malformations of the jaw, will be rendered evident by a few typical examples. Fig. 23 represents an extreme

Fig. 24.



instance of a common variety, a protrusion of the central incisors, apparently due to an abnormal outgrowth of

the anterior portion of the alveolar processes. A somewhat similar deformity of the lower jaw (Fig. 24) (Tomes), gives rise to projection of the lower beyond the upper front teeth. An individual affected with this deformity is said to be underhung. The V-shaped or contracted arch, instances of which daily present themselves, is illustrated in Fig. 25. This gives rise to al-

FIG. 25.

most endless varieties of displacements of the teeth. The incisors or bicuspids are often forced inwards, and the canines, appearing after these are in position, remain external and prominent. The deformities due to crowding in that class of case in which a small though well-shaped jaw contains disproportionately large teeth, closely resemble those occurring in the V-shaped maxilla.

In a somewhat rarer example of deformity (Fig. 26) (Tomes) the molars alone approximate on closure of the jaws and the incisors remain apart and cannot be brought into contact. This is in consequence of a malformation of the posterior portion of the lower jaw, as a result of which the molars, being placed on too high a level, prevent the rest of the set from coming together.

These examples will suffice to render manifest the distinction between the two great classes of irregularities, and little would be gained by multiplying them. In any case except the simpler instances of the first class, in which removal of the cause is enough to bring

FIG. 26.

about a cure, it may be necessary in the first place to consider the expediency of extracting permanent teeth for the sake of obtaining space; next comes the question of the extraction of such malplaced teeth as are not amenable to mechanical treatment; and lastly, there is the construction and application of a mechanical apparatus when it is required for the completion of the treatment. With regard to the extraction of permanent teeth for the sake of affording room, it may be at once stated that the sacrifice of an incisor or canine, is rarely necessary or justifiable. They are the most durable of the teeth, they contribute most to the symmetry of the dental arch, and moreover a tooth may generally be

chosen, the removal of which will better serve towards the desired end. The choice will as a rule fall upon the first molar. This tooth is the most liable to decay, and even in early life is often so extensively carious as to require extraction, or at least is in a condition so defective that it cannot be expected to last many years. After the extraction of a tooth from a crowded jaw the pressure is relieved, and the teeth spread equally apart until in a comparatively short time (very rapidly in early life) the space previously occupied by a large tooth becomes obliterated. In most cases to relieve crowding it is desirable to remove a tooth at each side of the jaw. If only one tooth be extracted, the movement of the crowded members takes place towards that side, and the regularity of the dental circle is disturbed.

Nothing conduces more to the onset and rapid advance of decay than a crowded, irregular condition of the teeth, and when this condition exists the removal of one or two even sound teeth has a highly beneficial influence over the future health of the rest of the set, and on this ground alone the operation is often advisable.

Should the first molar be free from defect, any other tooth which shows signs of decay, or of imperfect structure, may of course be chosen instead, and where doubt exists, the relative liability of the different classes of teeth to decay will govern the choice. This liability has been ascertained from carefully collected statistics. The first molars, as just stated, are much more often attacked by decay than any others of the teeth; next in this respect come the second molars; after these the second bicuspids; fourthly, the first bicuspids; fifthly, the lateral incisors; sixthly, the canines; and lastly,

the central incisors are less frequently the seat of caries than any other teeth of the set. Space having been obtained by the extraction of teeth, nature may be trusted unaided to effect a cure in some few cases of irregularity due to crowding alone, in which the direction of the teeth is good, and where they are not locked in their malpositions by those of the opposing jaw; but in many cases mechanical treatment will be necessary.

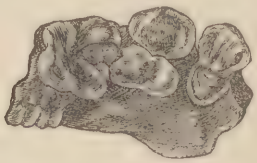
Numerous instances, however, present themselves in which one or more teeth are so far displaced as to preclude the possibility of their reduction by any means to their proper positions. Such instances are specially those in which not only the crown, but the entire root is out of its normal situation. For example, an upper canine being erupted after the lateral incisor and bicuspid are in position, often presents itself external to and prominent over the space between these teeth, which is too narrow to contain it. When the direction of the canine is correct it will in time take its proper place if room be afforded, but should it appear in an oblique direction and with its root lying at an angle across the alveolar border, as in the case depicted in Fig. 27, it is unlikely that it could be brought into the desired position even were mechanical treatment employed. In such cases the extraction of the malplaced tooth is the sole resource. An example of an irremediable displacement of a bicuspid of a kind which is also frequently met with in the case of other teeth is shown in Fig. 28, from Wedl. The wisdom teeth more than any other of the set are liable to total displacement of this kind, for the reason which has been mentioned in a previous section, in speaking of the eruption of these teeth—namely, that they make their appearance after the rest of the

teeth are in place, and when insufficient room in the jaw for their normal progress remains. Displaced wis-

Fig. 27.

dom teeth do not call for interference unless they constitute a source of discomfort or give rise to irritation.

Fig. 28.



When this occurs extraction may be performed without hesitation, the tooth from its position being useless in mastication.

Instruments for the purpose of regulating the teeth are constructed to fulfil several objects—to prevent the locking together of the teeth or closure of the mouth, and to exert such continued pressure or traction on those that are displaced, that they may be gradually compelled to assume their normal positions. It has been seen that irregularities vary between the simplest kind — mere slight displacements of growing teeth—and the severest form associated with malformation of the maxilla. It will be understood, therefore, that the effect required to be produced in different cases by mechanical treatment

varies also considerably; and it will be perceived also that the treatment can be carried out much more rapidly and effectually in the child than in the adult. At the former period of life when the alveoli are in process of growth a malplaced tooth can be drawn into position in a short time, and with the exercise of but slight force, whereas at a later date, the jaw having become consolidated, the treatment becomes long and tedious. It will be evident also that in the simplest cases the instrument is not required to do much more than guide the developing tooth in the desired direction, whilst in the more difficult, it will be necessary to keep up such pressure as shall cause absorption of the bone which opposes the movement of the tooth. To give rise to absorption by continued pressure, it is well known, is not difficult either in the jaw or in other bones. The precaution must be taken in dental cases not to cause irritation sufficient to pass into destructive inflammation. Some amount of congestion or perhaps even inflammation of the slightest extent must necessarily accompany the absorption, but it is not difficult to arrange the apparatus to exert with great nicety any amount of force required, without exciting inflammation of undesirable severity. The more slowly the teeth are moved the less danger will there be of mischief arising. It is only experience in each case that can determine the degree of force which may be safely applied, and it is well, therefore, to commence always with a small amount, and gradually increase it.

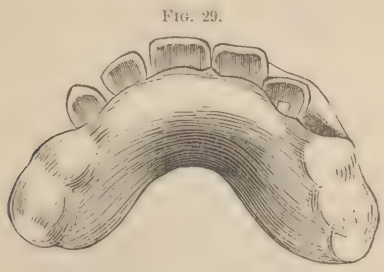
That the movement of teeth under the influence of pressure must be accompanied in some instances by absorption of bone is beyond doubt, but from the fact that the opportunity for post-mortem examination never pre-

sents itself during the treatment of these cases, the exact mode in which the changes in the tissues are effected cannot be ascertained, and for a similar reason it is impossible to explain the well-known circumstance that even after the absorption of bone has been apparently induced, and the teeth have taken the desired positions, they tend invariably to fall back into their former situation unless mechanically fixed by the teeth of the opposing jaw, or retained for a considerable time by an instrument constructed for the purpose. Thus in the case shown on a previous page, Fig. 16, the treatment might cease safely so soon as the upper teeth had been pushed into their normal position, in front of the corresponding lower teeth when closed; whilst in such a case as depicted in Fig. 21, if after the reduction of the deformity the treatment were discontinued a relapse would speedily take place. In all such cases as the latter, after the irregularity is cured, a plate must be arranged to hold the teeth in their new positions, and must be worn from six months to two years, according to the age of the patient and the severity of the deformity.

The simplest form of regulating apparatus consists of a plate accurately adapted to the teeth and gums, the crowns of the molars being covered when desirable with a sufficient thickness to prevent the upper and lower front teeth from meeting. A fixed point is thus provided to which screws, springs, or levers, elastic bands or wedges of wood, may be attached to act upon the teeth in any desired direction. The material of which the plate is constructed may be either metal (gold or silver) or vulcanized india-rubber. Either of these materials answers almost equally well; some operators prefer one, some another. The author believes that vulcanite has some

slight advantages over metal. It is easier to make it firm in the mouth. If a perfect model be taken and the plate vulcanized upon it, the accuracy of the fit alone in most instances will suffice to fix it in the mouth. Additional rigidity may be obtained by paring the model slightly at the necks of the temporary molars before vulcanizing, and after this it is rarely necessary to attach the plate by ligatures, an expedient which must be adopted more frequently where metal is used. Vulcanite again affords a more congenial surface for mastication than metal, and it is less liable to chafe the surface and injure the enamel of the teeth with which it is in contact. Of whatever material the plate is constructed it ought to be removed at intervals of a day or two for the purpose of thoroughly cleansing it as well as the crowns of the teeth which it envelops.

Fig. 29.



In order to make the character of these instruments clearly understood, the description of two or three cases will suffice. Fig. 29 shows in position the instrument employed in the regulation of the case represented in Fig. 30. This was an irregularity of a simple kind, one upper lateral incisor being displaced inwards, and held in its malposition by the lower teeth. The plate cover-

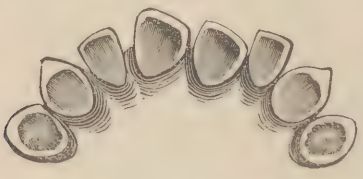
ing the molars kept the jaws sufficiently apart to prevent the front teeth from meeting, and the obstacle to the forward movement of the tooth being in this way removed, but a slight amount of pressure was required to force it into its right position. The pressure was obtained by a

Fig. 30.

wedge of compressed hickory fixed in a chamber in the vulcanite behind and in contact with the irregular tooth, the moisture of the mouth causing the wood to expand and in expanding to push the tooth slowly forward. The wood was renewed by larger pieces at intervals of a day or two, as the cure progressed, until the tooth having been driven sufficiently outward the patient was dismissed.

The next case (Fig. 31) was of a somewhat different character. The irregularity consisted of a twisting of

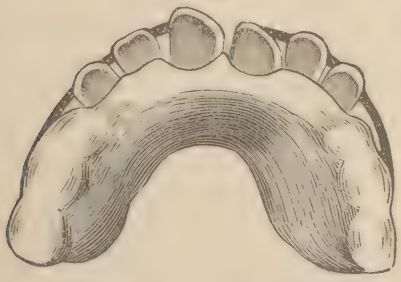
Fig. 31.



the central incisors on their axes. It was probably of congenital origin. The instrument with which it was treated is shown in position in Fig. 32. It consisted of

a vulcanite frame closely in contact with the inner angles of the twisted teeth, but clear of the rest of their surfaces. From each side of this frame there proceeded a flat spring of hard gold wire, and these extending round in front were so arranged, that their free extremities kept

Fig. 32.



up constant pressure on the prominent edges of the incisors. In this way the distorted teeth were compelled

Fig. 33.

gradually to revolve, and the deformity was in time entirely removed. Fig. 33, from Mason (10), illustrates

another method of treating these irregularities. A metal plate is fitted to the mouth, backing the twisted incisors, and carrying screws to act upon the inverted angles, whilst a metal bar passing round in front, and pressing upon the prominent surfaces, causes the teeth to revolve instead of move forward.

Cases like the last, in which the teeth are merely turned in their sockets, are treated by some practitioners by an operation which has been called "actual torsion." This operation is performed by seizing each tooth firmly with a pair of forceps, and slowly and deliberately turning it by force, until reduced to its proper position. By this means it is believed that the alveolar wall may be made to yield, and the tooth turned without permanent rupture of its vascular connections, or injury to its vitality. The forceps ought to be specially constructed with broad flat blades lined with leather, or better with lead, so as to avoid crushing the tooth or damaging the enamel. A plate previously prepared must be in readiness for insertion immediately after the operation, and must be worn for some months to retain the teeth in the new position. The subjects of this operation ought to be young children in good general health. There must obviously exist, after the operation of "actual torsion," a danger of the occurrence of inflammation, perhaps involving the loss of the tooth, but such untoward results are stated to be, in well-chosen cases, extremely rare. Symptoms of inflammation would be best treated by leeches to the gum, followed by warm fomentations and the administration of a saline purge. The advantage of "actual torsion" consists in the rapidity with which a cure is accomplished; but in proposing the operation, it must be borne in mind that it

involves unquestionably a risk, whilst the desired effect can be produced with certainty by other means, without any danger whatever.

Cases similar to that shown in Fig. 23 may be treated by an instrument (Fig. 34) much the same as in that

Fig. 34.

illustrated in Fig. 32. In these cases, however, the gold wires are made to terminate in front of the canine teeth, and each has affixed at its extremity a small gold stud or hook. An elastic band stretched between these hooks over the faces of the protruding teeth, affords the pressure necessary to reduce them in time to their proper position. The same effect might be produced equally well by means of elastic bands passed over the teeth, and attached behind to the surface of the plate; but this method sometimes causes discomfort by interfering with the movements of the tongue, or with the lower teeth, during mastication. An apparatus of this kind is depicted in Fig. 35, from Mason (10). The plate is of metal. The projecting central incisors are acted upon by elastic ligatures attached to a stud on the lingual

surface of the plate. The lateral incisors being displaced inwards, are forced in the desired direction by

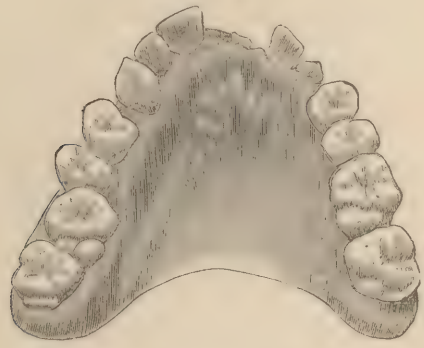
Fig. 35.

screws passing through the plate, and pressing upon their posterior surface.

The following case, the models of which are in the museum of the Odontological Society, illustrates several points in the treatment of irregularities. In June, 1873, a young lady, then aged fourteen, received a blow in the mouth which caused a fracture, extending vertically through the crown of the left upper central incisor. In January, 1875, she was brought to me, when finding the fracture involved the root, and rendered its preservation impossible, I extracted the tooth. The accompanying cut (Fig. 36) shows exactly the appearance of the upper jaw after this operation. The right central and lateral incisors, and the left canine, fell considerably beyond the range of the lower teeth on closure of the mouth, whilst the right canine and first molar were displaced inwards, the cusp of the former locking within

the lower teeth. Considering all the circumstances, it was deemed preferable to attempt to regulate the teeth, and to bring about at the same time closure of the gap in front, rather than to condemn the patient to wear an artificial tooth. An apparatus was accordingly made to exert constant outward pressure, by means of wooden

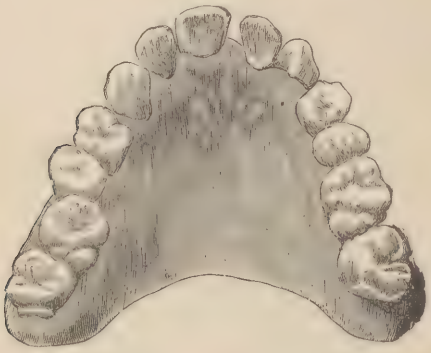
Fig. 36.



wedges, on those teeth which were within the normal dental circle, and flat springs of hard gold wire were brought round at each side in front, to act in the opposite direction upon the projecting incisors and canine. The next engraving (Fig. 37) shows the effect produced after three months of this treatment, by the exercise of an amount of force so slight as to give rise throughout to no irritation beyond a trivial passing tenderness of some of the teeth. The rapid favorable progress of this case was due to a great extent to the youth of the patient, and to the ample room which the loss of the incisor provided for the spreading apart of the crowded teeth, and their movement in the desired directions. The

case is still under treatment, and no doubt in a short time still greater improvement will be effected in the arrangement of the teeth.

Fig. 37.



By contrivances similar in action to those already described, the entire alveolar border of the jaw might be modified in form. For instance, in the contracted or V-shaped palate, an apparatus would be made to maintain equal pressure from within outwards along the alveolar margin of the jaw, until in time the required expansion of the arch could be accomplished. Some few cases may be advantageously dealt with by instruments fixed externally. Thus, the case depicted in Fig. 26, would be treated by constant upward traction of the chin, a cap of leather adapted to that part being attached to a strap across the head by strong elastic bands at each side, as seen in Fig. 38.

It is not within the scope of this manual to enter further upon a description of all the numerous expedients which may be adopted in the devising of instruments

for regulating the teeth. Enough has been said to make clear the principles upon which the construction and action of the apparatus are uniformly based, and indeed these principles alone being understood, there are few

Fig. 38.

cases which can present serious difficulty to any operator possessing a moderate amount of mechanical ingenuity.

CARIES.

Caries, or decay of the teeth, consists essentially of a process of gradual softening and disintegration of the tissues, due mainly to the action of acid. The onset of the disease is favored, and its progress is hastened primarily, by certain structural defects in the enamel and dentine, and secondarily, by some diseases of the oral mucous membrane and some derangements of the general health. The progress of the disease is accompanied by pathological changes in some of the tissues affected by it. Commencing invariably at the exterior, it advances towards the interior of the tooth, forming a cavity which increases in size until the crown, and even the greater part of the root also are destroyed. It is attended with pain, which often commences in a mild form as soon as the dentine is slightly penetrated, and becomes most severe when the central chamber is laid open, and the pulp, being exposed to the action of external irritants and to injury, becomes the seat of inflammation.

The acid, the active agent in caries, may be derived from several sources. It may be secreted by the mucous membrane. The normal secretion of the membrane is small in quantity and slightly acid. In health the acid is at once neutralized by the alkaline saliva, with which it mingles; but when the membrane is congested or inflamed the mucus increases in quantity, and becomes more strongly acid in character, and is sufficiently

powerful to slowly dissolve the dental tissues. This may be proved by experiment. If a small pellet of cotton-wool, or other foreign substance, be forced between two teeth, and left so as to press upon the gum, the secretion from the mucous membrane at that point will be found in the course of a few hours increased in quantity and strongly acid. If this irritation be kept up, it will be seen after a short time that the enamel of the teeth adjacent to the acid secreting surface is undergoing slow solution.

During the decomposition of particles of food which, mingled with shreds of mucus and other such substances, lodge about the teeth, acid is formed which is capable of producing an effect exactly similar to that just described.

These statements with regard to the susceptibility of the dental tissues to the action of acids have received ample corroboration from the results of experiments upon extracted teeth. Teeth submitted to the influence of dilute acids not more powerful than would be generated in the mouth under the circumstances above mentioned, become slowly decalcified. Magitot allowed teeth to remain in a solution of lactic acid in the proportion of one part of acid to 100 parts water, and in a solution of butyric acid of similar strength, and in citric acid solution one part acid to 1000 water. After the lapse of two years it was found that the roots of the teeth immersed in the two first mentioned solutions had become flexible owing to the abstraction of their earthy constituents, and the enamel was chalky, friable, separated from the coronal surfaces in places, and readily reducible to a white powder by trituration. The dentine presented a general brown discoloration.

Citric acid acted in the same manner, but with greater

rapidity. Fluid containing fermenting albuminoid substances—such as are represented in the mouth by particles of food and shreds of mucus lodged about the teeth —were found to produce precisely similar effects. During the putrefaction of these substances fatty acids are formed of the acetic and benzoic series.

Teeth immersed in either of the aforementioned fluids, but protected from their action, except at one point, become affected at the exposed portion by softening and disintegration exactly resembling in essential characteristics true caries. In the mouth there is of course always added to the action of acid the decomposition of the animal basis of the tissues, which is accompanied and hastened by the development of low vegetable organisms presently to be mentioned.

Caries may commence on a sound unbroken surface of the tooth, especially on the lateral aspects, close to which acid is commonly generated by the decomposition of particles of food and irritation of the mucous membrane. It frequently has a starting-point at some part of the enamel and dentine, the seat of structural defects. Imperfections in structure, from which few sets of teeth are altogether free, may be owing to defect either in the quantity or in the quality of the tissues. Defects in quantity consists of pits and fissures in the enamel and dentine. These vary in extent between minute cracks perceptible only under the microscope, and cavities plainly visible by the naked eye. They may penetrate the enamel alone, or may extend to a greater or less depth into the dentine also. Their most common situation is in the depths of the natural depressions in the contour of the tooth, as for example between the cusps of the molars. Fissures which involve the dentine as well

as the enamel are the most favorable to the attacks of caries.

Defects in the quality of the tissues may affect the whole body of the tooth or may be confined to certain spots in the enamel and dentine. The fact is well known that the durability of the dental tissues varies considerably in different individuals—in one the teeth withstand the extremest hard usage combined with neglect, in another they show traces of disease within the earliest years of childhood, and are destroyed sooner or later even in spite of active treatment. If the enamel and dentine of such delicate teeth be examined, it will be found that they present well-marked evidences of imperfect formation. The enamel instead of appearing a densely hard, almost homogeneous mass, is comparatively soft owing to imperfect calcification, and porous in consequence of incomplete coalescence of its formative elements. It retains a marked fibrous character. The fibres are imperfectly blended; their transverse striæ are clearly evident, and they are often penetrated at their centres by tubes or small cavities. At parts the fibrous character may be altogether lost, the tissue consisting of an imperfectly united granular mass.

The dentine in addition to undue softness exhibits throughout its structure, and especially immediately beneath the enamel, patches of defective tissue similar in character to the granular layer which in well-formed teeth exists only at the point of juncture with the cement. In the spaces within this defective tissue—sometimes called interglobular spaces—the tubes end, or they may even run on and terminate in dilated extremities within the substance of the enamel.

It does not always happen by any means that all the

structural defects which have been just mentioned in the quantity and quality of the dental tissues exist together in one tooth. Their degree and character vary considerably. It is not uncommon to find in teeth of otherwise good organization one or two pits or fissures, or small patches of defective tissue; whilst in teeth of generally inferior structure there are often to be discovered portions of still feebler formation.

The local and constitutional diseases which favor the onset and progress of caries are those which are accompanied by, or which tend to aggravate inflammation of the oral mucous membrane, and those which give rise to the formation or deposit of acid within the mouth. Among the former may be particularly enumerated all the varieties of stomatitis; among the latter scrofula, syphilis, phthisis, diabetes, chlorosis, and chronic alcoholism. These constitutional affections exert their baneful effect upon the teeth in great part by reason of the chronic inflammation of the gums, the vitiation (even general acidity) of the secretions of the mouth, and the dyspepsia with which they are all so commonly accompanied. For the same reason caries is frequently active during pregnancy. During febrile diseases, in which the secretion of saliva is scanty and the teeth remain coated with sordes, accumulations of epithelial scales, viscid mucus and other foul secretions, caries, as might be expected, is often originated, and when previously present is always accelerated.

The fact that enamel and dentine are readily soluble in the acids the presence of which in the mouth commonly arises from various sources, and that structural defects in the enamel and dentine not only furnish places favorable for the lodgment of acid-forming substances,

but at the same time render some portions of the teeth more readily acted upon than others, suffice to explain both the origin of caries and the reason why the disease commences at certain isolated spots, and does not affect uniformly and at once the entire surface of the crowns of the teeth.

The physical signs of caries, consisting mainly of discoloration and softening of the tissues, bear a general resemblance in every case. They differ only in consequence of the mode of onset, the situation, and rapidity of the disease. The discoloration in the incipient stage on an unbroken surface of enamel usually amounts to no more than slight opacity of that tissue, a condition which also as a rule prevails throughout the later stages on the borders of the cavity of decay. When the disease begins in a fissure, and when a cavity is formed, the discoloration is more marked, the softened dentine assuming a brown tint, or becoming stained to a blackish hue by decomposition, aided by the entry of foreign substances, and by the deposit of the peculiar fungoid growth, the leptothrix buccalis. Cavities in which the disease extends deeply and is progressing rapidly show least discoloration.

The softening or disintegration perceptible in the successive stages of the disease varies considerably. When a surface of enamel is first affected it appears eroded, rough, and full of small holes, and is readily scraped away by a steel instrument. When the mischief has commenced in a fissure, but little softening may be apparent for a time at the surface, until later the undermined enamel breaking down or being cut away discloses a cavity in the dentine filled with disorganized tissue. Such a cavity is formed in every case in the

later stages of the disease. Carious cavities are often cone-shaped, the apex of the cone being at the surface. This form of cavity (which more particularly arises where a fissure has existed) is due to the more rapid destruction of the deeper than the superficial parts. The former are kept in intimate unceasing contact with the acid-generating contents of the cavity, whilst the latter are as constantly washed by the alkaline saliva. Then again when caries penetrates to a mass of interglobular substance, it is easy to understand how the disease advances with greater rapidity at that part than at the superficies. The differences in the physical character of the disease have given origin to such distinctions as spreading, penetrating, soft and hard caries.

Microscopical examination of carious teeth shows that the action of the acid is more energetic in some elements of the tissues than in others. Thus in the enamel the central portion of the fibres is as a rule the first to be removed, whilst in the dentine the intertubular substance and the walls of the tubes are the first to disappear, leaving the sheaths and fibrils, the animal basis of the tissue, to become subsequently decomposed and destroyed. The tubes at the later stages of the disease appear dilated, and present occasional varicosities. Besides the disintegrated tissues and foreign particles, there is to be found by the microscope in most carious cavities abundance of the peculiar fungoid growth leptothrix buccalis, similar to that which is deposited upon the surfaces of the teeth in all mouths in which the most extreme care is not taken in frequently cleaning the teeth. The leptothrix assumes the appearance of minute threads projecting from the surface of the carious dentine in enormous numbers. It enters and occupies the disorganized and dilated tubes,

forming a molecular mass therein, and it penetrates the tissue in every direction in which the calcareous salts have been removed. It has been supposed by some few observers that the leptothrix, if not the exciting cause of the disease, takes the principal part in promoting the advance of caries. There is no more than the slightest evidence to support the former part of this opinion, and but little to substantiate the latter. It can be conceived, however, that the growth may have some share in hastening the destruction of the already decomposing tissues.

Examination of carious teeth in various stages of decay demonstrates the fact that certain changes apparently take place prior to actual disintegration in that portion of dentine through which the disease is advancing, and which is situated immediately contiguous to the already disorganized tissue. This altered dentine has a translucent appearance, and forms either a regular zone, or exists in isolated patches around the walls of the cavity. The appearance was once thought to indicate invariably a vital or pathological action, a natural effort to arrest the disease by calcification of the dentinal fibrils, similar to that which occurs as a natural phenomenon as age advances. Such a change does doubtless really occur in some cases, especially in slowly advancing caries in teeth of good formation, and it renders the tissue harder and better able to resist the progress of decay, and even sometimes to arrest it altogether. It is found, however, that a precisely similar translucent appearance is always produced during the gradual softening of dentine by acid, and to this softening and not to consolidation, the appearance in caries is due in the majority of instances.

Enamel being devoid of sensibility the pain during caries (as already stated) does not begin before the den-

tine is affected, and it is due in the earlier stages of the disease solely to the exposure of this sensitive tissue to sudden changes of temperature and pressure of foreign particles and contact with irritating substances. In the later stages pain arises from the transmission of similar irritation to the pulp when that structure is either insufficiently protected by a layer of dentine, or actually exposed. Finally, if the disease run on, there is added the pain due to the extension of the inflammation from the pulp to the peridental membrane.

The amount and character of the pain in all the phases of caries are much diversified in different persons. In some there is almost from the beginning constant pain of a dull aching character, augmenting from time to time as decay advances into severe or even agonizing paroxysms, whilst in others the teeth are altogether destroyed without any suffering beyond slight occasional aching and uneasiness. It is impossible to account for this difference, but it may be noted that the very young suffer as a rule more acutely than adults or the aged, and that in certain conditions of health, of which pregnancy furnishes the most striking instance, toothache, if it occurs, is usually of the severest kind. Leaving out such exceptional cases it may be broadly stated, however, that in the vast majority of instances there comes on from time to time, after the dentine is affected, slight attacks of transient aching, particularly after entry into the cavity of irritating substances, such as sugar and salt, and a smart pang slowly subsiding is often inflicted when a hard fragment of food is forced in during mastication.

The pathology and symptoms of irritation and inflammation of the pulp of dental periostitis associated with caries are discussed in a later chapter. It may be re-

peated that the most severe pain which arises during the progress of caries is due to inflammation of the pulp. It is by the extension of this inflammation that the dental periosteum becomes involved. When periostitis has supervened the tooth becomes slightly loosened, and exquisitely sensitive to the touch.

It is a remarkable fact, and one that has some practical application (as was seen in a preceding section), that the teeth are not all equally liable to be affected by caries. Series of cases have been tabulated from time to time by various observers, and these agree in the main with each other. The following statistics of 10,000 cases collected by Magitot, show the relative frequency of caries in the different kinds of permanent teeth:

Central incisors,	642	Superior,	. . .	612
		Inferior,	. . .	30
Lateral incisors,	777	Superior,	. . .	747
		Inferior,	. . .	30
Canines, . . .	515	Superior,	. . .	445
		Inferior,	. . .	70
First bicuspids,	1310	Superior,	. . .	940
		Inferior,	. . .	370
Second bicuspids,	1310	Superior,	. . .	810
		Inferior,	. . .	500
First molars, . .	3350	Superior,	. . .	1,540
		Inferior,	. . .	1,810
Second molars, .	1736	Superior,	. . .	690
		Inferior,	. . .	1,046
Third molars, . .	360	Superior,	. . .	220
		Inferior,	. . .	140
	10,000			10,000

The first point which attracts attention in these tables is the great relative frequency of caries in the first mo-

lars; the next the much greater frequency of the disease in the front teeth of the upper than in those of the lower jaw. The latter circumstance may perhaps be accounted for by the fact, that the lower front teeth are protected from the action of acid by the saliva with which, owing to their position, they are constantly bathed. It must be admitted, however, that no entirely satisfactory explanation of the ratio of frequency presented by the several classes of teeth has yet been afforded.

TREATMENT OF CARIES.

PREVENTIVE—THE INCIPIENT STAGE—THE OPERATION OF FILLING THE TEETH.

Preventive Treatment.—The pathology and etiology of dental caries being understood, it will be obvious that much can be done to prevent attacks of the disease, and to delay its progress. The treatment of constitutional conditions predisposing to decay of the teeth, falls beyond the province of the dentist, and although it can be therefore only mentioned here, too much stress cannot be laid upon its importance. If it be omitted, the most active local measures may prove in some cases ineffectual.

Locally, the prophylaxis of caries in part consists in combating diseased conditions of the mucous membrane of the mouth, which are attended with vitiation of the secretions; but as these conditions are discussed in later pages, there need be considered here only the means which are available locally in preventing the formation of acid, the active agent in caries, in neutralizing it, and in preventing its hurtful effects upon the teeth. Foremost among these means must be placed the maintenance of the mouth in perfect cleanliness. The teeth should be carefully brushed, at least twice daily, and the patient should be taught not only to cleanse their external surfaces, but to apply the brush to every part which it can reach. The spaces between the teeth

should be frequently freed from the particles of food which lodge there. For this purpose a few threads of floss silk, or a fold of any similar soft material slipped into the spaces, and rubbed briskly to and fro, answers well. Tooth-powders and lotions are of considerable value. Tooth-powders ought not to be made of materials like levigated pumice, which are often used to whiten the teeth, and which produce this effect by grinding away the enamel; but should be composed of strongly alkaline, bland, and soluble substances, having no more mechanical power than enables them to remove the well-known soft fur which coats the surfaces of the teeth in most mouths, even within a few hours after every application of the tooth-brush. The desired objects are well fulfilled by such a mixture as that of precipitated chalk and soap, commonly known as saponacious tooth-powder. The soap, of which a nearly tasteless variety is used, having been dried, is pulverized and mixed with the chalk, and to this there may be added perfume and flavoring ingredients, to render the dentifrice agreeable to the patient. A powder having as its principal ingredients chalk and a soluble alkali, such as carbonate of soda, is almost equally efficacious.

Mouth-washes may be composed with advantage of tincture of myrrh or of rhatany. The spirit which these tinctures contain, besides rendering them more astringent, is antiseptic, and it is a good plan to use them to moisten the floss silk, or other material which is employed in cleansing the spaces between the teeth. With the same design, Eau de Cologne, lavender-water, and similar perfumes, are pleasant applications. With these lotions there may be combined carbonate of soda, or other soluble alkalies, when the acidity of the secre-

tions is great, or where the patient is obliged to take acid medicines.

Perhaps the most beneficial procedure that can be adopted for the prevention of caries, in cases in which the teeth are of a generally defective structure, and *where great crowding of the teeth exists*, is the extraction of two or more permanent teeth from each jaw, during the period of second dentition. In such cases, after the second molars are in place, the first, which are often extensively carious, can be well spared; but even when sound, their sacrifice will be repaid, in many instances, by the improved condition of the remainder of the set. Not only does the room afforded by the equal spreading apart of the teeth render the origination of caries less possible, but it enables the cleansing of the interstices to be easily performed, and affords the dentist the opportunity of detecting, and dealing with the decay in these difficult situations, in its incipient and most amenable form.

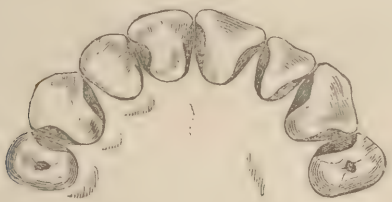
The treatment of incipient caries may be confined, in many instances, to cutting away the diseased tissues, polishing the surface, and leaving it of such a form that it may be readily cleansed, and not allow of the adhesion of decomposing particles of food. This procedure is in imitation of an operation which is sometimes effected accidentally during the progress of the disease, and which suffices to arrest permanently the process of carious disintegration. The disease occasionally commences on the grinding surface of a tooth, the external portion of which is of defective structure. This portion having been destroyed, the denser subjacent tissue is laid bare, and becomes smoothed and highly polished by mastication, whilst at the same time calcification of the dentinal

fibrils gradually takes place, and renders the surface extremely hard.

The treatment of caries by the simple operation of excising the diseased tissue is applicable only in rare cases to the grinding surfaces of the teeth, but is commonly resorted to with success in dealing with decay of the contiguous surfaces, especially those of the incisors and canines. The operation is performed under the most favorable circumstances when the enamel alone is affected, but it may be often carried out with permanent advantage even when the dentine has been penetrated to some depth. As a rule it should not be undertaken in mouths where chronic inflammation and sponginess of the gums prevail; neither should it be proposed in any case when the carious surface extends below the gum. At the level of the gum it is desirable in many cases that a portion of sound tissue should remain projecting from each tooth, so as to prevent their surfaces from coming into close apposition. The rest of the surfaces should be left perfectly plane, and with such an inclination towards each other that the space between them is V-shaped, the wider part so directed as to be easily accessible to the tooth-brush and to the tongue, and subject to the constant beneficial friction of mastication. In forming the surfaces in this manner it is of course necessary to cut away a considerable quantity of sound tissue. The amount which may be safely removed varies with the size of the tooth, but it must be borne in mind throughout, that if too much be removed the tooth may be left unbearably sensitive, owing to near exposure of the pulp. In the case of the incisors and canines the excision of sound tissue may be confined always to a great extent, and sometimes entirely, to the

lingual aspect of the teeth, which are thus preserved from perceptible disfigurement. The instruments required in the operation consist of enamel chisels and files; with the chisels—when applied in the direction of the enamel fibres—the decayed tissue may be rapidly and painlessly broken down; with files of different degrees of coarseness the operation may be continued, and the surface made ready for the final polishing. This latter process is accomplished by rubbing the surfaces first with finely powdered pumice, carried on tape or on a strip of cane, to remove the file marks, and afterwards with a strip of wet slate-stone, to make it perfectly smooth. Fig. 39 (from Arthur) shows the

Fig. 39.



most favorable form in which the interstices of the teeth can be left after this treatment. The slight sensibility in the exposed dentine, varying in amount in different cases, which often remains for a time after the operation, may be rapidly diminished by the occasional application of solution of chloride of zinc, or the use of a lotion containing spirit.

The operation of Filling the Teeth.—When, owing to its extent or to other circumstances, caries cannot be dealt with by the method just described, it must be treated by the operation of plugging or filling the tooth. This

operation comprises cutting out the diseased tissues and forming the cavity for the retention of the filling, drying the cavity, and filling it with some suitable material. It is conducted always on the same principles, but its details vary somewhat according to the position, character, and extent of the decay. The present section will be restricted to the treatment of cases in which the central chamber of the tooth has not yet been laid open by the caries, and in which the dental pulp is free from disease.

The operation of filling, throughout all its details, is much facilitated by the use of a dentist's chair, which allows the patient to be firmly and comfortably placed in the most suitable position, raised when a tooth of the upper jaw, and lowered when a tooth of the under jaw, is to be filled, with the head tilted forwards or backwards, the face turned towards or from the operator, according to the position of the tooth and of the cavity of decay.

The instruments used in excising the carious tissues consist of enamel chisels, drills, and excavators. The chisels are sufficiently described by their name, both as regards their nature and use. They are made with blades of different sizes, bent at various angles, so as to reach the decay wherever situated. With them the carious enamel of the walls of cavities can be speedily broken down with but little pain to the patient. The chisel should be held firmly with the handle in the palm of the hand, the thumb being lodged securely against the tooth to control the instrument and to prevent it from slipping. It should be applied in the direction in which the enamel fibres run.

Dental drills are of two kinds, the rose or bur-head,

and the sharp-pointed drill. The cutting point of the rose-head forms a circular or conical file. It is used to open up the ragged orifices of cavities and to grind away the carious tissues within. The sharp drills serve to open up small cavities and fissures in the enamel, to shape the cavity, and to cut retaining points into which the filling is to be dovetailed. These drills are now commonly employed in conjunction with the burring engine. This instrument consists of a flexible shaft rotated by a band, which is driven by a treadle and fly-wheel. The extremity of the shaft carries burs, grinding wheels or drills of any desirable size and shape, and, revolving with great rapidity, enables the operator to excise the tissues with great nicety, and speedily to reduce to smoothness the ragged or rough surfaces.

Excavators serve to pare away the dentine. They are made of all sizes, with flat blades, sharp-pointed, curved and bent at various angles to reach the differently situated cavities.

With regard to the performance of the preliminary step in the operation of filling, at present under discussion, it may be laid down in the first place as a rule, subject to important exceptions to be mentioned further on, that the whole of the carious structures should be removed. If the margin at least of the cavity be not formed of sound tissue, decay will proceed unchecked after the insertion of the filling. At this part of the cavity the beginner is much more liable to err, by too limited than too free use of the chisel and excavator. In the next place it must be observed, that although the sensibility of the teeth varies in a great degree in different individuals, the excision of the carious tissues is always a more or less painful operation. In most

cases, however, it will be found that it inflicts no more than an easily bearable amount of pain, when it is done rapidly with instruments thoroughly sharp. The suffering may be lessened in all cases, by applications which diminish the sensibility of the dentine. Amongst the most useful of these applications in common use, may be mentioned chloride of zinc and arsenious acid. The cavity may be swabbed with a strong solution of the former, or a minute quantity of the latter may be applied, and this will usually have the desired effect. These remedies, especially the latter, must be used with great caution when the pulp is nearly approached by decay, lest they penetrate to that structure and excite inflammation.

The exceptions to the rule with regard to the excision of the whole of the carious tissues, present themselves in cases in which the pulp-cavity is closely approached by the decay. In such cases the greatest care must be exercised to avoid laying open the chamber, for, if this accident happen, the chances of saving the tooth are much diminished. When danger of the accident exists, the softened dentine must be slowly and cautiously removed, and if it be found that the excision of all the affected dentine cannot be accomplished without risk, it is better to leave a layer of partly decayed tissue of sufficient thickness in the depths of the cavity. Carious dentine, in the earlier stages of decay, may be, in fact, always left with safety in the deeper parts of large cavities, and in the later stages, unless utterly disorganized, it can be brought into such a condition, and placed under such circumstances as will prevent it from decaying further. Caries — it has been shown — cannot go on without the influence of external agencies, and all that

is wanted, in the cases in question, is in fact to harden so far as possible the diseased tissue, to abstract completely its moisture, and to protect it by a permanent filling from the action of these external agencies. Partially disorganized dentine may be hardened by filling the cavity with a plug of cotton-wool, saturated with a solution of gutta-percha and tannin in chloroform, or gum mastic in spirits of wine—a dressing of wool with carbolic acid being applied beneath, and the whole being renewed at intervals of a few days, over as long a period as necessary. In many cases, the drying alone of the tissues by means of a hot-air syringe, or better by the application of absolute alcohol, will suffice. This process is described on a later page.

There are no grounds upon which the deliberate exposure of a healthy pulp during the progress of excavation can be justified. Like other somewhat similarly situated structures of the body, the pulp, whether it has been wounded or not, is very commonly attacked by inflammation, after mere exposure to the air, in consequence of the opening of the chamber in which it is confined. The existence of a layer of partly disorganized tissues treated as described, and inclosed beneath a filling in the depths of a cavity, can be productive of no harm. If it be cut away, it must be afterwards replaced by a cap—an artificial substitute, the application of which is difficult, which often sets up irritation, and which, even if of the most perfect construction, must be necessarily less adapted to its purpose than a layer of imperfect dentine.

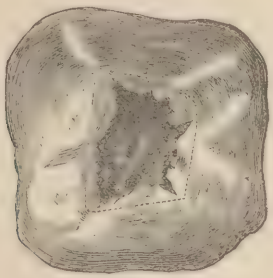
In excavating the tissues preparatory to the insertion of filling, it is necessary not only to remove decay, but to adapt the cavity for the retention of the plug. It

will be presently seen that, with one exception, none of the materials used in filling teeth adhere as cements to the walls of the cavity—they are all retained by either plugging, wedging, or dovetailing. The simplest kinds of cavities are such as, after removal of the decay, assume the form of a hole or trench with vertical walls; and those which require most modification are such as have a narrow irregular orifice, and those which either wholly or partly take the form of a shallow saucer-shaped excavation. It being impossible to pack a filling beneath the overhanging margins of a cavity, these portions must be, when necessary, freely cut away, whilst, as it is also impossible to fix a plug upon a shallow concave depression, the walls of such a cavity must be rendered either vertical or slightly undercut, or retaining-points may be formed. Retaining-points are made by drilling small pits in different parts of the cavity. Into these pits portions of filling are packed, and to these portions, more and more being securely joined, the whole mass is fixed immovably in position. The number, size, and depth of the retaining-points must be regulated according to the circumstances of the case. They need never be very deep, and of course due care must be taken in using drills to avoid laying open the pulp-cavity.

The annexed enlarged diagrams may serve to make this subject more clearly understood. Fig. 40 exhibits the aspect of the commonest form of simple cavity in the grinding surface of a molar. Such a cavity, after the excavation of the carious tissues, including the enlargement of the orifice to the extent indicated in the dotted lines, would require no further modification to fit it for the reception of a filling.

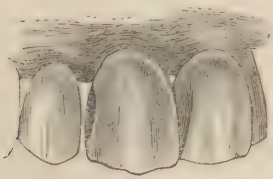
Fig. 41 shows a cavity after excavation on the lateral surface of an incisor. The cavity is of some depth to-

Fig. 40.



wards its centre; but from that point slopes gradually in every direction towards the lingual and labial margins, and towards the cutting edge and neck of the tooth. It forms, therefore, a uniformly concave saucer-shaped cav-

Fig. 41.

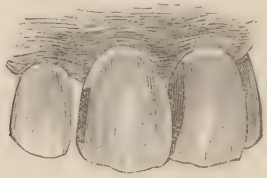


ity incapable of retaining a filling. Such a cavity might well be prepared by giving it the form of a trench, as shown in Fig. 42, with slightly undercut walls, rendering it a little smaller at the orifice than within.

The next diagrams illustrate the formation of retaining-points. A cavity of typical character on the lateral surface of an incisor is shown in Fig. 43. After re-

moval of the carious tissues, it forms a shallow concavity, broad at the upper part and sloping and narrowing towards the cutting edge of the tooth, near which

Fig. 42.



point it terminates. The preparation of such a cavity would consist, after slightly deepening the labial and

Fig. 43.

lingual walls, in drilling two pits (as shown in Fig. 44) in the upper aspect, and one in the lower angle of the depth and in the direction indicated by the dotted lines.

The later section on gold filling will be further explanatory of this subject.

The difficulties which present themselves in dealing with cavities, which being situated on the contiguous surfaces of teeth, are neither fully visible nor sufficiently accessible, must be overcome either by free chamfering, or by temporarily forcing the teeth apart. The benefi-

cial effect of permanently separating teeth was explained in the section on the treatment of incipient caries, and the procedure there described must be adopted in the

Fig. 44.

majority of cases preparatory to the filling of the cavities in question. In treating the incisors and canines the plan described in the section on incipient caries must be adhered to, and the chamfering must be as far as possible confined to the lingual aspect of the teeth. This suffices in most cases to render the cavity accessible to the filling instruments from behind, whilst the labial surface remaining intact, the normal appearance of the tooth is preserved, and the filling, unless large, is rendered invisible to casual observation. The instances in which it is better to force the teeth temporarily apart are those in which small cavities exist in teeth—especially front teeth—of otherwise sound structure, and where permanent separation would cause disfigurement. Sometimes the plan may be well adapted of chamfering the affected surfaces to some extent, and pressing the teeth apart in order to obtain the further space necessary for the use of the filling instruments.

The temporary separation of teeth is easily effected by

slipping between them a strip of india-rubber, and allowing it to remain for twenty-four hours. A very slight amount of pressure suffices for the object; the rubber should not therefore be thicker than the space which it is desired to make, and this space should not be greater than suffices to allow the use of the necessary instruments. If much force be exercised great pain is set up, and the presence of the rubber soon becomes intolerable. After the removal of the rubber the teeth fall together again in the course of a few hours, and the tenderness which the process has caused also rapidly subsides.

A similar effect can be produced by packing a plug of cotton-wool, saturated with mastic cement, between the teeth, and allowing it to remain for a day. This plan is preferable in cases in which a mass of swollen gum projects into the cavity, the pressure of the plug causing the mass to shrink and forcing it out of the way of the instruments.

During the subsequent steps of the filling operation, the insertion of a wooden wedge between the necks of the defective teeth is often useful. A piece of compressed hickory of suitable size is cut so as to fit with a moderate degree of tightness, the V-shaped space which naturally exists between the necks of the teeth. This is steadily pushed between the teeth, and the ends being cut short, it is allowed to remain until the filling is completed. The use of a wedge alone in this manner, in some cases in which the teeth are not closely in contact, is sufficient to afford room for the satisfactory performance of the filling operation. The wedge often also subserves the purpose of forcing away the gum and preventing it from bleeding and from being wounded by

the files and other instruments. It also often serves to hold in position the rubber dam.

Drying the Cavity.—The cavity having been prepared for the reception of the filling, the next step consists in drying it and guarding against the access of moisture until the completion of the operation. The difficulty in accomplishing the latter part of this process is much greater in every case at some positions in the mouth than at others, whilst the extremely profuse flow of saliva in certain patients is even under favorable circumstances hard to control. The teeth situated at the anterior part of the upper jaw are the most easily managed, the orifices of the salivary glands being distant, and the fluid naturally gravitating towards the back of the mouth. In most cases during the filling of upper incisors, canines, or bicuspids, the cavity may be kept dry by the insertion of a roll of cotton-wool beneath the lip, a fold of napkin being at the same time laid across the lower front teeth, to prevent the tongue from carrying up moisture from beneath.

The duct of the largest salivary gland—the parotid—opens through the mucous membrane of the cheek, where it lies against the upper molars, and its flow must therefore be directed or controlled before these teeth can be dried. Where the flow is not profuse, and the cavity is situated on the masticating surface, precautions such as described for the front of the upper jaw may suffice. In other cases these measures may be supplemented by the temporary closure of the orifice of the duct. This may be accomplished by the application of clamps specially contrived for the purpose, or the exit of saliva may be sometimes prevented temporarily by a small patch of impervious sticking plaster.

In the lower jaw the exclusion of the saliva during plugging presents more difficulties than in the upper. The saliva naturally accumulates in the floor of the mouth, and the movements of the tongue and the efforts of swallowing have a constant tendency to throw it over the crowns of the teeth. In patients who cannot swallow with the mouth open the difficulties are increased. Where the tooth has to be kept dry for no more than a moment or two the influx of saliva may be guarded against by the insertion of a roll of wool or of bibulous paper beneath the tongue, and another between the cheek and side of the jaw, these rolls being firmly held in position by the fingers of the left hand. In more prolonged operations the tongue-depressor is extremely useful. By it the tongue can be held down, and any desirable amount of pressure can be kept upon the ducts of the glands which open in the floor of the mouth.

It will be found in the majority of cases possible to keep the faulty tooth dry during the insertion of the filling by the means just described, which were those alone available until late years. There has, however, been recently introduced the contrivance known as the rubber dam. This simple invention, for which the profession is indebted to Dr. Barnum, of the United States, enables the dentist to keep the tooth perfectly dry throughout the most prolonged operation. The dam is formed of a thin sheet of india-rubber specially prepared for these operations. A piece is taken a few square inches in size, and towards its centre is punched a small hole, one about as large as an ordinary pin-head being big enough for a molar. This hole is stretched and slipped over the tooth, so that the rubber closely embraces the neck and leaves the crown surrounded by an impervious

dam. In practice it is well to make a series of holes in the rubber the same distance apart as the crowns of the teeth adjoining the one to be operated upon, and to pass the rubber over them also. By this means the rubber is securely fixed and kept effectually out of the way.

Difficulties in applying and securing the dam arise where the teeth are in extremely close contact, and where, from the conical shape of their crowns, the elasticity of the rubber causes it to spring off. The first of the difficulties may be overcome by forcing down the highly stretched rubber by a thin strand of waxed floss silk. It is found that by the pressure of the tense thread the teeth can be forced slightly apart at the point where their crowns are in contact at the masticating surface, and this point being passed, the rubber is readily carried down to the gum, at which position an interval invariably exists between the teeth. To prevent the dam from springing off the tooth a steel clamp of suitable design may be used. This clamp grips tightly the neck of the tooth, and forms a projecting flange, under which the rubber slips, and is thus held secure. The same purpose is fulfilled by the insertion of wooden wedges between the teeth after the dam is applied. The dam having been fixed by one of these methods, the borders of the rubber projecting from the mouth may be turned back and held out of the way by hooks attached to elastic bands passing over the patient's head. The rubber dam gives less annoyance to the patient, whilst answering the purpose better than any other contrivance of the kind, besides which it leaves both hands of the operator free for the manipulation of the stopping instruments.

The influx of saliva having been guarded against, the cavity has next to be dried, a comparatively easy mat-

ter. It may be done roughly by wiping the surface with cotton-wool, or better with bibulous paper, or amadou. It is however by no means easy to procure perfect dryness by mere wiping with these materials. Better to achieve this end several varieties of hot-air syringes have been devised, by which the moisture may be driven off by a current of heated air. These instruments are superseded by the use of absolute alcohol, in the manner first suggested by the author. When applied to a wet surface, the alcohol, having a great affinity for water, combines with it, and if exposed to the atmosphere evaporates. In this way it not only carries off the superficial moisture, but it also abstracts the water which the tissues intrinsically contain. Cavities to be dried with this fluid should be first wiped out with wool and then swabbed with a small pellet saturated with alcohol. After a pause of a moment to allow the spirit to unite with the water, the cavity can be again wiped with dry cotton, and this will leave a surface as dry as could be obtained by the hot-air syringe. The swabbing and wiping can be repeated when called for, as in those cases already referred to under a previous heading, in which it is desired to harden a layer of carious dentine, which to avoid exposure of the pulp must be left in the depths of a cavity beneath a filling. Like every other fluid which has a strong affinity for water, absolute alcohol will of course produce irritation if allowed to flow upon the skin or mucous membrane, although this will be but slight if the surface be wet and the quantity of spirit small. Accidents of this kind need not occur if ordinary care be taken.

The materials used in filling teeth may be conveniently arranged for the purpose of description according to their

durability in the mouth. One (gold) only is practically imperishable, several others, although subject to slight physical and chemical changes, are sufficiently lasting to deserve the name of permanent filling, whilst a third group, being liable to rapid decomposition, must be classed as temporary fillings. Permanent fillings are, of course, always intended to act as substitutes for the tissues destroyed by disease. Temporary fillings—as was noted incidentally in the section on excavating the carious tissues—are used in the preparatory treatment of cavities. Further explanation of their employment in the same and in other ways will appear in later chapters.

With regard to the choice of materials in cases ready for the reception of permanent fillings, it may be said that there occur few cavities in which the insertion of a gold plug is impossible, and regarded from a merely theoretical point of view the instances are rare in which the use of any other material as a stopping intended to be permanent is justifiable. Practically, however, it is often necessary to employ inferior and less durable substances. In the first place the expense of gold puts it beyond the reach of the lower and of the poorest classes. In the next place, the operation of gold filling in large and difficult cavities is long, tedious, and frequently painful, and there are many patients who either cannot or will not submit to it. Lastly, exceptional cases occasionally present themselves, as for example, in neglected caries of a front tooth, in which the crown—the preservation of which is of great importance—is so extensively excavated as to form a mere thin shell of enamel, incapable of withstanding the force required in gold filling. In all such instances the substitute for gold best adapted to the circumstances must be employed. With Sullivan's

cement, the author in hospital practice alone has filled and saved in a useful condition numbers of grinding teeth which must have been lost had there not been available any such material, at once inexpensive and rapid of application; whilst he has seen an equal number of fragile front teeth preserved for years by such comparatively perishable materials as oxychloride of zinc, and especially gutta-percha.

The gold used for filling teeth is pure—without any alloy whatever—for in this condition alone it possesses the qualities necessary for the production of perfect plugs. It is prepared by the manufacturers in two forms—in foil and in a spongy mass. The leaves are produced by beating, the sponge is formed by precipitating the metal from a solution. The leaf gold suitable for filling teeth, is much thicker than that which is used in gilding, and comes to hand in sheets about four inches square, the lightest of which weigh four grains. Thicker qualities are made to suit the fancy of different operators, and the exigencies of cases. Sheets from four to six grains in weight are the most generally useful. Two qualities of gold foil are manufactured for dental purposes, non-adhesive and adhesive, and these differ in the fact that pieces of the former pressed together do not cohere, whilst portions of the latter forced closely into contact become inseparably united. These peculiarities are due to difference in the molecular condition of the foils, the adhesive variety being more crystalline in character than the non-adhesive. The adhesive quality of all foils is increased by annealing, and the non-adhesive variety may be rendered adhesive by the same operation. The adhesive property of pure gold (when in a certain molecular condition), is one that it possesses in common

with some other metals, such as platinum, silver, tin, and lead, which are comparatively soft at ordinary temperatures. The adhesion is in fact due to welding, the metals being capable of union of this kind when in their cold state, just as iron, and some others are when rendered plastic by heat. Sponge gold, owing to its perfectly crystalline form, is the most adhesive variety prepared for dental purposes. The adhesive property of gold is destroyed by moisture, but can be again restored by annealing.

Tin foil, of which permanent fillings can be made, is composed of the pure metal. It is sent out by the manufacturers in leaves of the same size as the gold foil, and in thickness about the same as six-grain sheets of that metal. Pure tin, as just mentioned, can be welded in the cold state, but the union cannot be brought about, unless the surfaces of the separate portions are bright and free from oxidation. This chemical change affects tin foil after a few hours' exposure to the atmosphere, and destroys to a great extent its cohesive property. This does not, however, much lessen its usefulness as a filling material. In plugging it is manipulated in the same way as non-adhesive gold foil.

Amalgam fillings come next to gold and tin in point of durability. These are all formed by combination of mercury, either with a single metal or with an alloy of several. Perhaps one of the first of these compounds used in dentistry, was that composed of coin silver and mercury. The silver reduced to filings was rubbed up in a mortar with mercury, until a stiff pasty mass was formed, which became hard in the course of a few hours. This amalgam, although of considerable durability under favorable conditions in the mouth, had the disadvantages

of becoming itself blackened by oxidation, and of gradually staining the tooth in which it was inserted. In spite of numerous attempts to do away with them, either or both of these imperfections in a greater or less degree are common to all the amalgams since introduced. Most of these have as their basis silver alloyed with small quantities of tin, gold, and platinum, the alloy being reduced to filings to facilitate union with mercury.

Palladium amalgam, and copper amalgam or Sullivan's cement, are each composed of pure metals with mercury. The palladium is manufactured for the purpose by precipitation, which produces a fine powder. Sullivan's cement is supplied to the dentist in the form of small solid pellets—masses of amalgamated copper and mercury. To prepare it for use, a sufficient quantity is placed in an iron spoon, and held over the flame of a spirit-lamp, until globules of mercury appear on the surface. It is then ground down in a mortar and forms a smooth paste, with an evident excess of mercury. It is then folded in wash leather, and forcibly squeezed until much of the mercury having escaped, the mass assumes a drier and somewhat granular character. This amalgam more than any other is subject to the disadvantages to which reference has been already made.

It has been proved by the experiments of Mr. Charles Tomes, that all the amalgams in common use contract during the process of hardening, although the extent to which this occurs varies considerably in the different compounds. The amount of contraction has been closely ascertained, by obtaining the specific gravities of masses of the amalgams when recently mixed, and afterwards when hardened. In the former state their density is found to be always less than in the latter, the difference being, of

course, due to contraction. It is obvious that when the shrinkage is more than infinitesimal in amount a permeable space must be formed between the filling and wall of the cavity after the hardening of the amalgam, and in such a case the stopping must necessarily fail to arrest decay.

The following table from Mr. Tomes's paper exhibits a comparison of the weight gained (*i. e.*, shrinkage) by different amalgams while hardening:

Palladium,	.037
Sullivan's,	.07
*Ash's,	.14
*Smale's,	.14
Tin and silver (55 to 45),	.35
Tin and silver (equal parts),	.38

The compounds marked with an asterisk may be taken as fair specimens of the amalgams in ordinary use, composed mainly of silver and tin, with a slight admixture of gold or platinum. These experimental results accord in the main with those of practice. Palladium amalgam and Sullivan's cement, when packed with due care, form plugs of great durability; whilst, although it appears probable that some of the contraction, which in theory would appear an insuperable obstacle to their employment, may be counteracted by skilful manipulation; and although in well-chosen cases they may endure for many years, still, in the majority of instances, the filling of a tooth with any other of the amalgams at present in use must be considered a merely temporary expedient.

Many points with regard to the properties of amalgams are still undecided. Among them the question as

to the proportion of mercury which it is best to use with the different compounds is still an open one, the balance of evidence being, however, in favor of the admixture of a quantity no greater than will suffice to produce a friable mass, which, under slight pressure, becomes coherent.

In the case of those amalgams whose basis is an alloy, the mercury should not be added in excess, and then squeezed out. The error should be corrected by the gradual addition of more filings. If the mercury be pressed out of such an amalgam, it carries with it an undue proportion of those of the constituent metals that are most soluble in it, and so the chemical character of the resulting compound is altered. Palladium and copper amalgam, on the other hand, may be freely mixed with an excess of mercury, care being afterwards taken to expel sufficient to reduce them to the proper degree of dryness.

In addition to staining the tissue, some amalgams have the effect of rendering the surface of dentine against which they rest extremely hard. This appears due to the saturation of the tissue to some slight depth by the metallic salts set free during the oxidation of the amalgam. In the case of Sullivan's cement the tissue in time becomes so hard as to resist effectually the further inroads of caries, and this effect doubtless has a share in increasing the permanence of this amalgam as a filling, counterbalancing the effect of the slight contraction which it undergoes whilst hardening.

Among filling materials of a more perishable nature than the metallic compounds just described, to gutta-percha may be assigned the first place; indeed, although its physical characters render it unfit to sustain the wear

of mastication, in power of resisting decomposition it is hardly inferior to the lower class of amalgams. For dental purposes, gutta-percha is prepared in the form known as Jacobs's and Hill's stoppings. These consist of gutta-percha bleached and intimately blended with silica, or some like substance, in the form of an impalpable powder, to render the material harder and more durable.

There has been introduced, during late years, a numerous class of useful compounds for temporary fillings, amongst which those known as Roberts's, Guillois's, and Fletcher's cements are of the most value. These are all mainly composed of oxide of zinc, mixed either with silica or marl. This pulverulent mixture, when required for use, is worked into a paste with a strong solution of zinc chloride. Chemical combination takes place, and a hard mass is rapidly formed, consisting of oxychloride of zinc, with the earthy ingredients mechanically mixed. These latter serve to impart greater hardness to the filling.

For the purpose of sealing up cavities in the teeth for a few hours or days, nothing answers better than a pellet of cotton-wool saturated with a solution of gum mastic in spirit, or of gutta-percha in chloroform. After the insertion of the pellet the fluid evaporates, leaving a tough mass impervious to moisture.

Instruments used in Filling Teeth.—A pair of plugging tweezers, a set of 18 pluggers, on Dr. Butler's pattern (Fig. 45), and a mallet, will be found sufficient in filling the vast majority of cavities with gold. The tweezers (Fig. 46) are for the purpose of carrying portions of gold into the cavity, and fixing them there prior to consolidation. Of the pluggers, seven or eight will have

serrated wedge-shaped points, of various sizes, and bent at different angles convenient for reaching cavities wherever situated. These are used for carrying gold into position, and in packing or welding it there. Six foot-pluggers of different patterns will be included in the

Fig. 45.

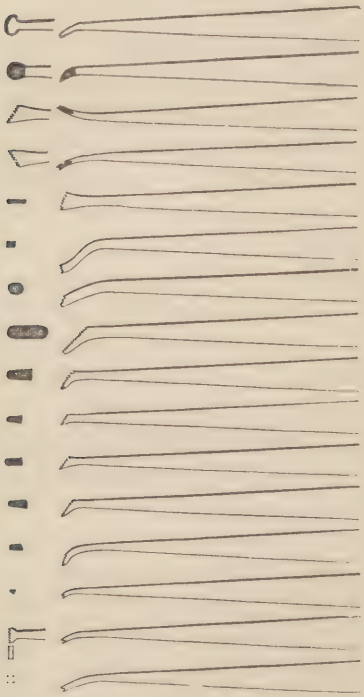


Fig. 46.

set. These serve to consolidate the component parts of the plug. In addition, there will be four or five instruments with working extremities, flat-faced and serrated,

and so bent or twisted on the shaft as to reach cavities to which straight foot-pluggers could not be applied. Lastly, there will be provided a burnisher, having a rounded, highly polished steel point. The mallet, especially useful with adhesive gold foil, supplements pressure of the hand in consolidating the filling, and in uniting its component portions. The same set of instruments serve in filling with tin foil. A set of instruments (six or eight), with smooth round steel points, are most suitable for packing amalgams. If the points which are used with these materials be serrated, the rough surface soon becomes clogged with amalgam, which lodges and hardens there, forming a layer, which, softened again by the mercury, is apt to mingle with an amalgam of another kind on a subsequent occasion.

A set of small spatulas are required for the insertion of oxychloride of zinc cement, and the blades of these may be advantageously made of silver or platinum, steel being rapidly oxidized and destroyed by these fillings. A similar set with smooth steel blades will suffice in packing gutta-percha.

Temporary plugs of cotton-wool and cement are easily inserted by means of ordinary excavators.

Filling with Gold.—It has been already stated that two varieties of gold—non-adhesive and adhesive—are used in filling teeth, and that their difference consists in the fact that fragments of the former kind do not cohere when pressed together, whereas separate portions of the latter may be welded and united into a solid mass. Plugs of non-adhesive gold must be formed always by the wedging together of folds or layers of foil; whilst on the other hand, in fillings composed of adhesive gold, the mode of arrangement of the successive portions is of

little importance, provided they be made to unite with each other. Although portions of non-adhesive foil do not actually coalesce under pressure, they become sufficiently dense to take a high polish, to resist mastication perfectly, and to constitute a stopping absolutely impermeable to moisture. Indeed it is much easier to make a water-tight plug of non-adhesive than of adhesive gold. An adhesive gold plug can be perfectly built up only when it is composed of small pieces slowly and thoroughly welded together. If an attempt be made to consolidate a mass of adhesive foil it condenses on the surface beneath the instrument and no amount of force which can be safely applied to a tooth is sufficient afterwards to affect the deeper portions which therefore remain imperfectly united and porous. The presence even of a trace of moisture, such as is liable to be deposited on the surface of the gold from the breath of the patient during the operation also prevents perfect welding from being accomplished. Either variety of gold, adhesive or non-adhesive foil or sponge, can be used exclusively in almost any cavity, but the properties of non-adhesive foil make it most useful in simple cavities—*i. e.*, those of the form of a hole or trench with vertical or nearly vertical walls —whilst the peculiar qualities of adhesive gold render it invaluable in irregular, difficult cavities, and where a plug has to be built up from a limited foundation. It is in many cases good practice to combine two kinds of foil, commencing with non-adhesive and using adhesive to build up the plug, or to key together securely the separate portions.

If the cavity be small in size and simple in form, the following method may be adopted. A sufficient quantity of non-adhesive foil—four to six grain sheets—is folded

lengthwise by means of a spatula into narrow ribbons, each containing a third or a quarter of a sheet. These ribbons are next cut into short strips, which may be conveniently spread upon a wooden tray covered with smooth woollen cloth. The point of a wedge-shaped plugger is next pressed upon a few of the strips one after the other, which are thus fixed lightly to the instrument. The gold is thus carried into the tooth and lodged, so that one extremity of the folds rests on the floor of the cavity and the other protrudes from the orifice. Portion after portion of gold is inserted in the same way, and forced against the walls of the cavity, until it becomes difficult to make the instrument enter. A smaller point is then used, and this is forced into the centre of the filling, the hole so formed being again filled with strips. The surface of the filling is next compressed by a broad, followed by a small pointed instrument. Finally it is filed smooth, and then polished by means of slate stone and water followed by a burnisher. The surface of gold fillings should be left convex in shape, and slightly above the level of the surrounding tooth, unless the projection interfere with the bite. They should not overlap the margin of the cavity.

This procedure may be varied by the use of adhesive gold towards the end of the operation to fill the holes made by the perforating instrument. Again the entire cavity can be filled with adhesive gold. A loosely folded ball or pellet is packed on the floor of the cavity, and consolidated, and to this piece after piece is added, each being thoroughly welded or kneaded to the mass by means of small pointed serrated instruments. Adhesive gold in the form of foil may be prepared for use in strips similar to those of non-adhesive foil, just described, and

like them may be carried into position on the point of a plugger; or portions of the foil or fragments of sponge may be torn from the leaf and fixed by the plugging tweezers, and afterwards condensed by other instruments.

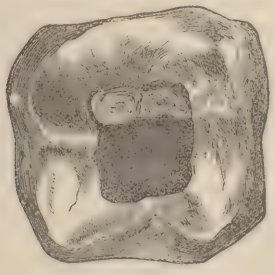
Large cavities of simple form may be most rapidly and effectually plugged with cylinders or rolls of non-adhesive foil. The cylinders are to be obtained of the foil makers, or they may be prepared by the operator. They are formed by winding a ribbon of foil round the point of a thin broach. They should be of such a size that several are required to fill the cavity, and of such a depth that when inserted endwise they project slightly from the orifice. Those used to commence the plug should be loosely rolled so as to be soft and malleable, but those for the latter part of the operation may advantageously be rolled more solidly or compressed slightly before insertion. In commencing the filling one of the cylinders is carried by the plugging forceps into the cavity and gradually condensed against one of the walls by a foot plugger. Another and another are then introduced in the same way until the cavity is full. A wedge-shaped instrument is then forced between the two last inserted cylinders, and the hole so made is filled with strips either of non-adhesive or adhesive foil. The rest of the surface may be next tested by a sharp-pointed plugger, and at any point at which it can be made to enter gold is added. The surface of the plug is finally filed down and polished.

In cases in which adhesive gold is to compose the whole or the greater bulk of the filling, the first and most important step consists in fixing portions of gold securely in the cavity. Upon these portions fragments of foil or sponge are successively welded until the cavity

is filled with a solid plug. In many instances the shape of the cavity after excavation allows of the secure formation of the foundation of the filling, or affords suitable positions for the packing of retaining-points without further preparation, and the filling is commenced with strips, pellets, or cylinders. In some cases small pits, or retaining-points of the kind already described must be cut, into which the gold being packed, the completed filling becomes dovetailed immovably in position.

The operation of filling with cylinders is illustrated in Figs. 47, 48, 49. In the first of these the commence-

Fig. 47.



ment of the filling is seen, two soft cylinders having been placed in position by the plugging forceps ready for consolidation, by the foot-plugger, against the wall of the cavity. The next diagram (Fig. 48) shows a later stage of the operation. The filling now approaches completion, the masses of gold are condensed, and a small central space alone remains to be plugged with strips of non-adhesive or fragments of adhesive foil. Fig. 49 exhibits this latter process in operation, and it also shows the proportionate extent to which a plug should project

from the cavity before the surface is finally consolidated, filed smooth, and polished.

Fig. 48.

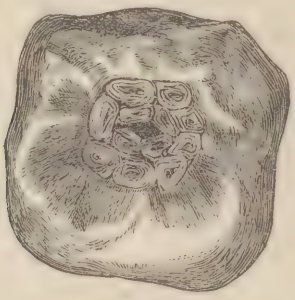


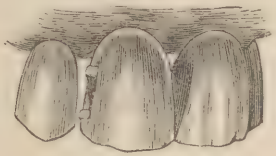
Fig. 50 shows a mode of beginning a filling with non-adhesive foil in a cavity of the trench-like form already

Fig. 49.

described, and illustrated in Figs. 41 and 42. The filling is commenced by fixing a mass of gold in the upper and lower extremity of the cavity. These masses may be composed of strips or small cylinders, and are made to project slightly from the mouth of the cavity. The filling is completed by packing between these buttresses

successive portions of foil in strips in the manner described in speaking of small simple cavities. If adhesive foil be used, either partly or entirely, the filling may be commenced in the same way, or a loosely rolled pellet may

FIG. 50.



be packed on to the floor of the cavity, and the plug is completed by welding to the first securely fixed masses, portion after portion of foil in the form of strips, pieces of loosely rolled ropes of foil or fragments of sponge or crystal gold.

Fig. 51 shows the commencement of a filling in the cavity already illustrated in Fig. 44, three portions of

FIG. 51.

gold being fixed in the retaining-points there displayed. Each of these pits or points has been separately dealt with as a simple cavity, and packed with strips, each mass of gold projecting beyond the orifice of the main cavity. This part of the operation being accomplished,

the construction of a plug on one of the methods already described presents no difficulty. The same principles are applied to the filling of more complicated cavities in which retaining-points are necessary, or in cases in which a plug has to be built up from a limited foundation. The first thing to be done is to form the points of support, anchorage, or foundation, care being taken that the masses of gold extend into the main cavity or project beyond its orifice when a filling on the wedging system is to be inserted.

In the construction of adhesive and non-adhesive gold fillings the consolidation and the welding of the metal is much facilitated by the aid of the mallet, an instrument which has come into general use in late years. A quick succession of sharp blows, carefully regulated, and given by a mallet of proper weight, does not inflict more pain upon the patient than the pressure of the hand alone, whilst the effect is to weld and condense the foil more rapidly and thoroughly. The heads of the hand mallets which are manufactured for this purpose are made of lead or some such soft metal, and weigh about 2 ounces. In order to facilitate the use of the mallet and to leave one hand of the operator free, automatic instruments are now constructed to which a series of plugging-points of various sizes and shapes can be adjusted as required.

Filling with Tin Foil.—This material is manipulated and packed in precisely the same way as non-adhesive gold foil.

Filling with Amalgams.—Many of the remarks which have been made with regard to gold apply equally to amalgams. The durability of these materials as fillings depends very much upon the mode in which they are

manipulated. They should never be inserted in a mass, but should be thoroughly packed piece after piece, and retaining-pits should be freely used on shallow sloping surfaces. It is important in packing to obtain absolute contact of the amalgam with the walls of the cavity, and to prevent a layer of mercury (which is often squeezed from the mass) from remaining around the forming plug. These objects are best achieved by rendering the cavity absolutely free from moisture, using the pluggers with a rubbing movement, and adding portions of the dryer amalgam to absorb the mercury as it oozes towards the centre of the cavity.

It is of the utmost importance after the filling has hardened to file it level with the margin of the cavity, and to polish it. If this precaution be neglected the overlapping portions of the filling in time break away, and leave a rough surface around, which favors the adhesion of decomposing particles, and soon becomes the seat of carious action. This precaution is even more important when either *oxychloride of zinc* or *gutta-percha* is employed as a filling. The former of these materials is used as a mortar or cement. It attaches itself with great tenacity to any surface which is perfectly free from moisture; it is the only filling which can be securely fixed by mere adhesion to the walls of the cavity; it forms a perfectly water-tight stopping; it is a non-conductor of heat, and were it not for its perishable nature it would perhaps constitute a more perfect substitute for the lost dental tissues than any other substance at present available.

In plugging with gutta-percha a mass of sufficient size is softened over the flame of a spirit-lamp, and packed into the cavity by means of heated instruments.

EXPOSURE OF THE PULP—DISEASES OF THE PULP.

Exposure of the Pulp.—In the last section the treatment of caries uncomplicated with exposure of the pulp was discussed, and the precautions were described which ought to be taken to prevent the laying open of the central cavity of the tooth during the excavation of carious tissue. This event is, however, sometimes unavoidable, owing to the complete disorganization of the dentine. Its occurrence will be known by the characteristic sharp pang which it inflicts, whilst on examination the exposed surface—from which, if wounded, slight bleeding takes place—is visible. If in such a case the pulp be free from disease the operation of "capping" the pulp, followed by filling, should be performed. The healthiness of the pulp may be inferred from the history of the case, and the absence of the signs and symptoms of irritation and inflammation to be presently mentioned.

The object of capping an exposed pulp is to provide a covering which shall protect the sensitive structure from pressure and from changes of temperature. Various materials, such as quill, parchment paper, gold-beater's skin, or thin sheet cork, are used for the purpose by different operators, and either of them answers well. When the exposure is but slight some are content with laying a few folds of gold foil over the surface. The hæmorrhage having ceased, the cavity should be

freely washed out by means of a syringe with warm water containing a small quantity of carbolic acid, and should then be dried. In this latter part of the operation in these cases absolute alcohol must not be used. Next a piece of the chosen material having been cut of suitable shape and size, is carefully fixed by the plugging tweezers over the opening into the pulp-cavity, resting upon the margin of the opening and closely in contact with, whilst at the same time not pressing upon, the subjacent pulp. The cap being thus arranged, the filling of the tooth may be proceeded with. Seeing that even in the best-managed cases irritation, or even inflammation, of the pulp sometimes follows this operation, and that the danger of this mishap is increased when a metal plug is inserted, which requires great pressure in packing, besides being a rapid conductor of heat, it appears desirable after capping to employ temporarily materials such as oxychloride of zinc or gutta-percha, which are not only non-conductors, but are easily inserted without pressure, and are readily removed on the occurrence of untoward symptoms. The author prefers the oxychloride, particularly in large cavities on the masticating surface of the molars. In these situations the filling can be trusted to endure at least for a few months, and within that time, if all goes well, it may be cut away, with the exception of a protective layer over the depths of the cavity, and may be replaced by a more lasting material.

Diseases of the Pulp—Irritation.—It has been seen that the dentine is intimately connected with the pulp by means of the fibrils which permeate it and endow it with vitality and sensibility. This connection renders intelligible the facts, firstly, that influences may be com-

municated through the dentine to the pulp in consequence of disease or injury affecting that tissue; and secondly, that the condition termed irritation of the pulp occasionally is produced during the progress either of caries or of abrasion of the tooth long before the central chamber has been nearly approached or opened. When the pulp is insufficiently protected by a thin layer of dentine only it is of course liable to be acted upon directly by external agencies. Irritation of the pulp is manifested by one symptom alone—namely, more or less dull aching pain, associated sometimes with a feeling of tenderness, and increased sensibility to changes of temperature, and it is not always easy to distinguish between this pain and the aching arising solely from exposed dentine. Sympathetic toothache, or that occurring in a sound tooth in the neighborhood of others the seat of advanced caries, has been ascribed to irritation of the pulp, but the pain in most of such instances is more probably neuralgic.

Irritation is liable to run on to inflammation, especially in cases of caries, in which the dentine displays exalted sensibility, and in which metallic fillings, rapid conductors of changes of temperature, have been inserted without previous treatment. If a pulp could be examined during an attack of irritation it would probably be found the seat of increased vascularity, disappearing with the cessation of the attack. Pulps which have been subject to long-continued irritation almost always become more or less calcified. The newly formed tissue is identical in structure with that already described as secondary dentine, and like it may be developed either in a layer organically united with the pre-existing tissue, or in isolated nodules scattered throughout the substance

of the pulp. When a layer of secondary dentine becomes developed over the surface of the pulp it protects the latter structure, and where waste of the hard tissues is in progress owing to attrition or to caries, it prevents the exposure of the pulp, which would be otherwise in the end surely brought about. Secondary dentine of this kind is often displayed in teeth which have been gradually ground down to the level of the central chamber by mastication.

The treatment of irritation of the pulp varies somewhat in different cases, but the indications always are to remove the cause by protecting the exposed tissues from irritating influences, and to diminish the sensibility of the dentine. Where the dentine has been laid bare, owing to fracture of the tooth or to attrition, and must remain ever after exposed, its sensibility may be often destroyed at once by solid chloride of zinc. The same effect may be more slowly produced by frequent friction of the surface with spirits of wine, or better by the occasional application of absolute alcohol, and with this treatment may be advantageously combined the use of tooth powders, containing astringents such as tannin, with alkalies like carbonate of soda.

When irritation of the pulp exists in connection with caries, the permanent filling of the cavity is in the great majority of cases sufficient to effect a cure. Caution must, however, be exercised where abnormal sensibility of the dentine exists, and it must be remembered that in some few individuals the insertion of a filling even in a cavity of slight depth in the dentine is enough to excite acute inflammation of the pulp. This danger is necessarily increased with the extent of the decay, and where the pulp is nearly approached, it is well to shield

it by a layer of oxychloride of zinc, in the manner which has been already described. The sealing up of a cavity for a few months with a non-conducting filling material is often alone sufficient both to abate sensibility of the dentine and to cure irritation of the pulp.

Inflammation.—This is the commonest affection of the dental pulp. Its most frequent cause by far is caries, which, having laid open the central chamber of the tooth, has exposed the sensitive structure within to the action of external irritants. It may arise (as was mentioned in the preceding section) from irritation communicated through the dentine when that tissue has been penetrated to a greater or less extent. In rare cases it originates as an extension of inflammation, which, having commenced in the periosteum, has involved the dental vessels and nerves in their passage to the pulp-cavity through the foramina of the root.

Inflammation of the pulp assumes either an acute or chronic form, and it gives rise to pathological changes in the tissues essentially similar to those occurring in other like structures of the body. It may produce gangrene, ulceration, suppuration, outgrowth of new tissue, or degeneration.

Pain is the most prominent symptom of *acute inflammation* of the pulp. It varies in amount according to the extent and intensity of the inflammatory action, is more severe in some individuals than in others—in the young than in the old—and in all is increased by some derangements of the general health, of which pregnancy affords the most remarkable example. At the commencement of an attack it is dull and aching, confined to the affected tooth, soon assuming a more intense lancinating or throbbing character, and finally, becoming

almost intolerable, it appears to spread to the adjoining teeth and to the whole side of the head and face. The pain of this form of toothache is more severe than arises in any other dental disease, and its severity is accounted for by the fact that the pulp, a highly vascular and nervous substance, is confined within the rigid walls of a chamber where swelling is impossible, and whence the inflammatory exudations cannot freely escape.

The diagnosis of acute inflammation rarely presents any difficulty. The character of the pain can hardly be mistaken, whilst in the vast majority of cases there exists a carious cavity in which after excavation of the softened dentine the pulp is exposed and visible. Where the opening is extensive the surface of the pulp may be seen red and injected with blood or dotted with suppurating points, and it bleeds readily and freely if touched. From dental periostitis it may be distinguished by the fact that in that disease the earliest symptom is tenderness upon pressure, and slight elevation of the tooth in the socket, whilst, where the pulp is alone inflamed, it is not until the last stage of the affection—when in fact the inflammation has extended to the periosteum—that these symptoms are displayed.

The tendency of acute inflammation of the pulp, which runs on unchecked, is to terminate in gangrene or sphacelus, but this termination is of most frequent occurrence when the pulp-cavity is but slightly opened, or where the pulp is altogether confined beneath a layer of dentine, or beneath a filling. Under such circumstances, there being no room for swelling, and little or no escape for the inflammatory exudations, such constriction is produced as causes death of the whole mass. Death of the pulp may be recognized by the cessation of the pain,

the insensibility of the dentine during excavation, whilst on examination the pulp is found devoid of sensation, softened and discolored, and emitting a characteristic fetid odor. The entire tooth at the same time assumes a darker tint, and occasionally becomes stained of a reddish hue in consequence of the diffusion of the coloring matter of the blood of the pulp through the dentine.

An attack of acute inflammation when the pulp is freely exposed rarely produces gangrene of the entire structure. The inflammation is sometimes limited to the exposed surface alone. In many cases swelling having taken place, and the exudation having found vent, the attack slowly subsides and assumes a chronic form, to be renewed again and again from time to time under the influence of increased irritation.

If a pulp the seat of acute inflammation be examined recently after the extraction of a tooth the affected portion will be found deeply red in color, the vessels being visibly injected, and small patches of extravasated blood will be observed upon the surface. Where swelling has been possible a red œdematous mass, studded, with suppurating patches, is found projecting into the carious cavity through the opening into the pulp-chamber. Some amount of suppuration is almost always present, but it is generally confined to the exposed surface, and abscess in the substance of the pulp is rarely formed. The general characteristics of a pulp in which gangrene has supervened have been already mentioned. Close examination shows that the tissues in this condition are reduced to a semifluid mass of a dirty reddish-gray or yellow color, with a marked gangrenous odor. In this mass portions of the disintegrated walls of the blood-

vessels, with numerous fat-cells interspersed, and disorganized nerve-fibrils, may be traced by the microscope.

The treatment of acute inflammation of the pulp must be modified in accordance with the circumstances of the case and the phase which the process has assumed. In some instances the extraction of the tooth is called for; in others the reduction of the inflammation and the conservation of the complete vitality of the tooth may be reasonably aimed at; whilst in a third group the extirpation of the pulp is the sole resource.

The extraction of the tooth is most frequently required in childhood. At this period an attack of acute inflammation usually runs a rapid course, the pain becomes excruciating, the inflammation quickly spreads to the periosteum, and the tooth becomes so exquisitely sensitive to the touch that manipulation of any kind is unbearable. The rapid spread of the inflammation in these cases is accounted for by the yet incomplete condition of the roots, the apices of which are represented by a portion of uncalcified pulp, freely communicating with the alveolar tissues. This condition renders inadmissible any attempt at the destruction of the pulp by means of escharotics in the manner presently to be described, whilst the advantages previously referred to, which in many cases accrue from the extraction of the first permanent molars (the teeth by far the most frequently the seat of caries in children), render their preservation inexpedient. In the temporary teeth, the roots of which are undergoing resorption, the course of acute inflammation of the pulp closely resemble that which takes place in the permanent teeth at the same age. The treatment of the affection, except by the extraction of the tooth, is in most cases unsatisfactory.

In the case of children, as in every other case of acute inflammation of the pulp in its earlier stages, the attack may be often cut short by removing the cause. With this view the cavity should be excavated, and in doing this with proper care it is possible to avoid wounding the pulp and inflicting (besides the injury) severe suffering upon the patient. Foreign particles pressing upon the pulp may be dislodged by the excavator, aided by the syringe and warm water, the free use of which should be continued to encourage bleeding from the exposed surface, should it occur. The cavity may be then lightly filled with a temporary plug of cotton-wool saturated with mastic solution, over a pellet of wool moistened with carbolic acid, and external irritation being thus guarded against, the inflammation will often subside. The temporary filling may be renewed at intervals of a few days. When all symptoms have disappeared the operation of capping the now healthy pulp and filling the tooth may be proceeded with. The cases favorable for this treatment are those in which the periosteum is unaffected and in which the pulp fully retains its vitality, not having been partly destroyed by gangrene or ulceration, resulting from former attacks of inflammation.

In cases in which preservation of the pulp is contraindicated the treatment consists in destroying its vitality by means of arsenious acid, in extirpating it, and afterwards permanently filling the chamber and root canals, as well as the external cavity of decay. A very minute quantity—less than $\frac{1}{20}$th of a grain of the escharotic—is sufficient to destroy the vitality of the pulp of the largest molar. The mode of applying it is as follows. The cavity having been excavated and dried, the arsenic

is carried to the exposed surface of the pulp by means of a few filaments of cotton-wool saturated with carbolic acid, and is then at once sealed in by a wool and mastic filling. The addition of a small quantity of morphia to the escharotic appears to prevent increase of the pain from this application. The pain is, however, rarely severe, and often altogether absent. The action of the arsenic being rapid, the treatment often, indeed, serves to arrest almost instantly the suffering arising from an aggravated attack of inflammation of the pulp. There are some disadvantages attending the use of wool with mastic solution as a covering for the escharotic. It is sometimes difficult to avoid pressure upon the exposed pulp, an accident which is attended with great pain, whilst the liquid constituents tend to wash away the pulp-destroying dose. These disadvantages are overcome by the use of beeswax as a temporary filling. A small piece of wax is carried by the tweezers to the cavity, and by means of a small heated spatula is melted over the orifice, so as to effectually exclude the saliva for a few hours. The spatula should have a wooden handle and a short metal blade, so as to avoid burning the patient's lips.

The temporary filling may be removed in about twenty-four hours, when it will be usually found that the pulp has lost its vitality, and that no pain results from probing the canal. It happens, however, occasionally, that in consequence of the smallness of the opening into the pulp-cavity, or of the presence of nodules of secondary dentine preventing the free access of the escharotic, the deeper portion of the pulp will be found to retain its vitality. In these cases the opening into

the chamber can be enlarged, and a second effectual application of arsenic can be made.

The devitalization of the pulp of single-rooted teeth —incisors and canines—can be effected instantaneously by means of instruments alone, and the pain of this operation, especially where the pulp has been previously destroyed to some extent by disease, is not so severe as might be supposed. The operation is performed by thrusting rapidly a thin flexible broach to the apex of the canal, and rotating it, so as to sever at once the vascular and nervous connections of the pulp.

The next step consists in removing the dead pulp. This is, as a rule, accomplished with little difficulty by means of the barbed pulp extractors especially made for the purpose. One of these instruments passed into the canal entangles the pulp, and brings it away on withdrawal. The operation is much facilitated by the free cutting away of the crown of the tooth, where necessary, to render visible—or at least to render accessible—the orifices of the canals, whilst if difficulty arise in consequence of smallness of the canals, or the presence of nodules of secondary dentine, they must be overcome by the use of fine flexible broaches. Some slight hæmorrhage from the canal usually follows the extraction of the pulp. When this has ceased, the filling of the canals may be proceeded with. Either gold or oxychloride of zinc cement may be employed, but the author has no hesitation in affirming that the latter of these materials is much the preferable of the two. In using it, it is seldom necessary to enlarge the pulp-cavity, as it can be made to flow into any canal into which a fine flexible wire will pass. The canals, after cleansing by the syringe and warm water, should be dried, and absolute

alcohol is valuable in this part of the process. Shreds of cotton-wool soaked in the fluid should be passed into each root, and allowed to remain for a few moments. By this means not only are the canals more thoroughly dried than is possible by any other means, but any minute particle of soft tissue which has escaped the nerve-extracting instruments is shrivelled by the spirit, and left in a condition in which, after insertion of the filling, decomposition is impossible. The oxychloride cement is next mixed to the consistence of cream. A few filaments of cotton-wool saturated with the fluid are then taken on the point of a wire or root-plugger of suitable size, and passed to the apex of the canal, portion after portion being afterwards carried in in the same way until the root is filled. The wool is used to facilitate the insertion of the cement, as it is often difficult to force the fluid alone into the depths of the canals. This, however, may be sometimes accomplished by carrying a portion of the liquid cement to the orifice of the root, and then with a pumping action, by means of a wire, having a few threads of wool fixed at its extremity, causing it flow into the canal. After the cement has hardened, the external cavity may be filled with a more durable material. The advantages of oxychloride of zinc over other substances used in fang-filling are the following. It is antiseptic in its properties; it forms a perfectly water-tight filling; it is a non-conductor of heat; it can be applied, as a rule, without enlarging the canals, and without other manipulation likely to set up irritation; and lastly, it can be easily removed by a drill and excavator, should it be necessary. The objection to the filling, owing to its perishable nature, which holds good in ordinary situations, does not apply in root-filling

where the material remains buried deeply beneath a plug, and protected from the action of decomposing agencies.

Filling fangs with gold is a more laborious operation, and presents no advantages over that just described. It is often necessary to open up the canals to a considerable extent before plugging instruments to carry in the gold can be made to enter. Gold is, moreover, a rapid conductor of heat; it is extremely difficult to remove when once packed, and in the author's experience its use in fang-filling is often followed by periostitis, a result which very rarely follows the employment of oxy-chloride of zinc.

Chronic inflammation of the pulp arises from the same causes which originate acute inflammation, by far the most common being the exposure of the pulp by caries. It often remains as a sequel to an acute attack, and again assumes a more active character, from time to time, under the influence of increased irritation.

The pain, usually of a dull aching or gnawing kind, is less severe than in acute inflammation, it may be almost altogether absent if there be a free vent for the discharges, or may be manifested at a distance in the form of neuralgia. The exposed surface is red, swollen, and pours out a thin puriform or serous secretion, having a characteristic phosphatic odor. On examination, the redness due to injection is found to be confined to the superficial portion alone of the pulp. This condition may resolve itself into a process of ulceration under which the pulp gradually disappears; in other cases degeneration and atrophy ensue, and effect complete destruction of the pulp, often without the occurrence of any pain.

In a certain number of instances chronic inflammation gives rise to the development of new tissue in the form of polypus of the pulp. This occurs mostly in young subjects, in teeth the crowns of which are extensively excavated by caries and with the pulp fully exposed. The new growth consists of a rounded fleshy mass, red or bluish-red in color, occupying or projecting from the cavity of decay, and may attain a size between that of a small pea and a Spanish nut. It is usually covered with an offensive muco-purulent secretion. It bleeds readily if wounded, but displays but little sensibility. Examination shows that polypus is united with the pulp, from which it springs, and that it consists of a mass of rounded and spindle-shaped cells, supported by a small quantity of fibrous tissue, and provided with numerous comparatively large bloodvessels.

Treatment.—In cases of uncomplicated chronic inflammation of the pulp in which there is neither an outgrowth of new tissue (polypus), nor loss of substance from ulceration or gangrene, nor periostitis of marked extent, an attempt may be made to bring the structure into a healthy condition. With this object the cavity having been excavated and cleansed, a dressing of carbolic acid, creasote, or chloride of zinc on cotton-wool may be lightly applied to the pulp, covered by a temporary filling. This must be renewed at intervals of a day or two until all symptoms of inflammation have subsided. The operation of capping the pulp and filling the carious cavity must then be carried out in the manner already described.

In cases in which there has occurred an outgrowth of new tissue sufficient to constitute a polypus, the extrac-

tion of the tooth is the sole treatment that can be recommended.

The treatment of a pulp partly destroyed by ulceration must be directed to the destruction of the remainder by arsenious acid, extirpation of the mass, and the subsequent filling of the fangs and cavity by the method already explained. It will sometimes happen (as before stated) that after repeated attacks of acute or long-continued chronic inflammation the pulp is entirely destroyed, and on examination the canals are found to contain nearly a semifluid mass of decomposing tissues. The treatment in these cases consists in thoroughly clearing out the canals, in disinfecting them by the application of carbolic acid, in afterwards filling them in the usual manner. It is in most of such cases well to dress the canals with carbolic acid at intervals during a week or more (keeping in a temporary filling), until all danger of periostitis, which sometimes supervenes, has passed away. This is a precaution which may well be adopted before fang filling, in all cases in which the occurrence of unfavorable symptoms appears probable.

DENTAL PERIOSTITIS—ALVEOLAR ABSCESS—PERIOSTITIS AND NECROSIS OF THE MAXILLÆ, DENTAL EXOSTOSIS AND NECROSIS—ABSORPTION OF ROOTS OF PERMANENT TEETH.

Periostitis.—Inflammation of the dental periosteum may be confined to one or two teeth, or may involve many or all the teeth of each jaw. The former variety is that most frequently met with, the commonest cause being the extension of inflammation from the diseased dental pulp. Periostitis also often arises after the filling of a cavity in which portions of suppurating or decomposing pulp have been improperly left, and in which the matter, not finding any escape, penetrates to the depths of the root canals, reaches the periosteum and sets up irritation. It may extend from one tooth, to those adjacent through the periosteum of the jaw, or may spread from the gums, inflammation of which indeed if at all extensive, always in some degree involves the periosteum. Periostitis may result from mechanical injuries of the teeth or alveoli, it may be caused by the continued inhalation of fumes of phosphorus, or may arise from rheumatism, syphilis or scrofula, or from cold, or from the effects of mercury upon the system (when, however, is is an extension from the gums), or from debility; whilst finally certain cases of general subacute or chronic periostitis, associated with absorption of the alveoli, frequently present themselves, in which the cause cannot be satisfactorily ascertained. Periostitis due to

constitutional causes usually affects several or all of the teeth of one or both jaws.

The symptoms of *acute periostitis* commence with a feeling of uneasiness in the affected tooth, which increases in the course of a few hours into aching pain, accompanied by tenderness of the tooth, especially when pressed into the socket as in mastication. If allowed to continue these symptoms increase in intensity. The pain becomes severe, and the sensibility of the tooth extreme; and the tooth is felt evidently protruded to a small extent from the alveolus, and slightly loosened owing to swelling of the lining membrane of the socket. The neighboring teeth become tender, the inflammation involves the neighboring gum and spreads thence to the palate and cheek, which become swollen and œdematous —the œdema often extending to the eyelids when an upper front tooth is the centre of the disease. With these symptoms more or less febrile disturbance is associated in accordance with the extent of the inflammation and the condition of the patient's general health. The tongue is foul, the breath tainted, the skin is hot, and there are thirst and headache. At this stage suppuration takes place, pus is formed, points and finds its way to the surface, and this is followed at once by diminution of the pain and by slow subsidence of all the symptoms. The acute stage of such an attack, uninfluenced by treatment, usually lasts from six to ten days. Perfect recovery may take place, the inflammation may remain chronic, it may end in partial or complete necrosis of the tooth, or spreading to the periosteum of the jaw, may cause necrosis of the bone to a greater or less extent.

On the extraction of a tooth the seat of acute perios-

titis, the periosteum in the early stage of the attack is found thickened, red, and injected; later it presents patches of lymph, and when pus has formed it is not uncommon to find a distinct sac containing matter attached to the extremity of the fang. This arises from suppuration of the internal layer of the periosteum, which becomes detached from the cement, thickened and dilated, and filled with purulent matter.

The treatment of acute periostitis must be governed by the cause of the disease and other circumstances, and although the great majority of cases yield to active treatment, the question of the extraction of the tooth will sometimes arise. Teeth or roots which have been long the seat of previous chronic inflammation, or alveolar abscess, or which are loose owing to absorption of their alveoli, may be often extracted without hesitation on the appearance of an attack of acute periostitis, whilst it is sometimes necessary to sacrifice a tooth to cut short the attack and avert the dangers of suppuration. And it may be here pointed out that if extraction be deemed desirable there need be no hesitation in performing the operation at any stage of the affection. There is a popular error on this subject, which prevails to some extent even among the more intelligent classes. The belief is, that it is both difficult and dangerous to remove a tooth when great swelling and inflammation of the soft parts are present, but there are no grounds whatever for such belief. The tooth is loose, and there are no special difficulties attending its extraction. No harm can possibly arise from the operation, whilst on the contrary in cases in which it is called for, much good must follow it, since the tooth constitutes the sole cause of the mischief.

If it be resolved to save the tooth, local abstraction

of blood and the assiduous use of warm fomentations are of the first importance in the early stages of the attack. One or two leeches can be easily applied to the gum over the affected tooth, and fomentation can be practiced by the patient washing the mouth with warm water. The carious cavity and the exposed pulp must be dealt with conformably to the circumstances by the methods described in the previous sections.

In most cases the administration of a brisk purge will be found beneficial. In some patients an ordinary saline draught, such as a Seidlitz powder, will suffice; to others, with muddy complexion, foul tongue, and constipation, calomel or blue pill, with colocynth, may be administered, followed by a saline draught if necessary.

So soon as swelling occurs, and even before pus can be detected, free incisions should be made through the gum down to the bone at the position where it appears probable matter may form, whilst at the same time the warm fomentations are persevered with.

Chronic dental periostitis may arise from any of the causes which originate the acute form of the disease. It often remains as a result of an acute attack, whilst periostitis due to constitutional causes is generally chronic, and rarely passes at all beyond a subacute stage. The symptoms comprise in a modified degree those present in acute inflammation. The teeth are tender on pressure; they are the seat of a varying amount of pain; they are more or less loosened and raised from their sockets, owing to the swelling within; and they are surrounded by reddened and swollen gum. On pressing the mucous membrane in some cases either pus or muco-purulent matter oozes from around the necks of the teeth, or escapes through a fistulous opening in the gum. These symp-

toms may continue for months or years, until becoming completely loose, in consequence of absorption of the alveoli, the teeth are at last lost.

Roots the seat of chronic inflammation exhibit various pathological changes. The periosteum is always thickened and more or less injected, and covered with patches of lymph. A complete sac, containing pus similar to those occurring in acute inflammation, is often found attached to the apex. In the same situation there are often found masses of fibrous tissue—hypertrophied root membrane—which are often undergoing ossification at the point of junction with the cement. In other cases partial necrosis exists, and the effects of absorption of the cement and dentine, indicated by a rough excavated surface, are commonly observable.

Treatment.—The question of the extraction of the affected tooth will arise in many instances, and must be decided in accordance with the circumstances of the case. The condition of the carious cavity (when one exists), the degree of loosening of the tooth owing to absorption of the alveolus, and the presence of symptoms indicating pathological changes in the cement, will determine whether there is a fair prospect of bringing the organ into a useful condition.

The first step in the treatment will consist in removing the cause—when discoverable—of the disease. When the inflammation is associated with disease of the pulp that structure must be dealt with by appropriate measures. Sources of local irritation, such as tartar deposited upon the necks of the teeth or necrosed roots must be removed. Local depletion is of considerable service, and the blood may be abstracted by incising deeply with a scalpel the swollen gum occupying the spaces between

the teeth. When the gum is separated from the necks of the teeth, and a purulent discharge is poured out, the part should be swabbed frequently with a solution of chloride of zinc—20 grains to an ounce—by means of a small probe and a pellet of cotton-wool, passed beneath the free edge of the gum. Lotions of permanganate of potash or carbolic acid may be used to overcome the fetor of the breath.

In periostititis due to or aggravated by constitutional causes, attention must be directed to the general health —rheumatism, syphilis, debility, and mercurialization, each receiving its appropriate treatment.

Alveolar Abscess.—Certain phases of the suppurative stage of dental periostitis constitute the conditions most commonly spoken of under the designation of alveolar abscess. This class of abscess is seen in its simplest and most familiar form in the ordinary gum-boil, which consists of a collection of pus between the gum and the bone, external to the root of the tooth, from which the disease originates. In severer forms of the same affection the cheek having become involved in the inflammation, great swelling having taken place, and suppuration to considerable extent ensuing, the matter if it do not find a ready exit into the mouth may point and burst externally. Thus there results a fistulous track between the diseased tooth and the surface of the cheek, which remains open and discharging as long as the inflammation continues. This termination, although it occasionally supervenes upon suppuration around other teeth, much more commonly follows alveolar abscess connected with the lower molars. Suppuration in alveolar abscess always commences in the socket at the surface of the tooth, but as

soon as matter forms absorption of the bone is set up and the matter escapes into the surrounding tissues. The external alveolar plate being the thinner, is almost invariably alone perforated, and the perforation often takes place with great rapidity, a few hours sufficing for the formation of a hole in the bone of considerable size. In some cases the thin alveolar plate becomes dilated and forms a bony sac around the abscess.

Abscesses connected with diseased teeth are usually traceable without difficulty to their origin. The matter does occasionally, however, burrow through the soft tissue and appear about the palate, cheek, or jaws in situations so unusual that the relation of the discharge to the teeth is not at first sight suspected. In cases of abscess about the mouth or face, the origin of which is not otherwise evident, it is therefore desirable that an examination of the teeth should be made.

When the matter escapes through the cheek the symptoms closely simulate necrosis of the jaw. The orifice of the sinus is surrounded by granulations, which often increase so as to form a papilla-like projecting mass, and from it issues a more or less constant secretion of purulent fluid. Such a case may be distinguished from necrosis of the bone by the following circumstances: firstly, that there is as a rule but one sinus when a tooth alone is implicated, whereas when a sequestrum exists there are several; secondly, dead bone may be detected by the probe; and thirdly, if necrosis have not taken place the symptoms speedily disappear on the extraction of the tooth.

The treatment of alveolar abscess is necessarily associated in many cases with that of dental periostitis, which has been already described. In the acute stage free in-

cisions into the swelling within the mouth and warm fomentations are the principal measures called for. Poultices and warm applications to the cheek should be avoided, as they encourage the escape of the matter through the skin. Painting the surface with tincture of iodine may assist in averting this danger. It must be remembered that although most cases either yield to treatment or subside after running a certain course, the progress of the disease may be arrested at once by the extraction of the tooth—an operation which may be performed without hesitation when the tooth is useless owing to chronic disease or extensive decay, or when the abscess threatens to burst externally. This latter event will be known to be imminent when fluctuation close to the surface is recognizable, and when the skin over the pointing abscess looks dusky or livid, and feels thin, and ready to give way. If the escape of pus through the skin appears inevitable, the abscess should not be allowed to burst spontaneously, but should be opened as soon as symptoms of pointing appear, in order to prevent the disfiguring cicatrix which must otherwise result in consequence of destruction of a portion of skin.

The treatment of chronic alveolar abscess must be directed first to the tooth and the exposed and inflamed or gangrenous pulp. The abscess having been then laid open by the bistoury, may be mopped out or syringed daily with a solution of carbolic acid, 20 grains to the ounce, or chloride of zinc, 20 grains to the ounce. These measures will in most cases suffice to effect a complete cure. In some instances, however, in which necrosis of the apex of the root exists, a small fistulous orifice remains permanently in the gum, from which a minute quantity of pus is constantly discharged, which

causes no inconvenience to the patient, who, indeed, often remains ignorant of its existence.

Periostitis and Necrosis of the Maxillæ.—The slight limited periostitis of the alveolus or jaw, which, from the intimate relation of the parts, is necessarily associated with the dental diseases just described, subsides in most cases on the removal of the cause; but in some instances the inflammation continues or extends, and may terminate in suppuration, followed sometimes by necrosis, to a greater or less extent, of the bone, in consequence of separation of the periosteum. On the other hand, cases occur in which inflammation, involving both teeth and bone, originates, independently of the teeth, in the periosteum of the maxilla. This form of inflammation may be caused by injury, such as fracture of the alveoli during extraction in an unhealthy subject, or by any of those constitutional conditions which give rise also to dental periostitis, and which have been already enumerated. C. O. Weber and Mr. Salter have both observed and recorded cases of a form of necrosis, which the latter has termed exanthematous necrosis. It occurs at the period of the commencement of second dentition in children, especially such as are badly nourished, who have been debilitated by attacks of the eruptive fevers. The necrosis in these cases is usually confined to the alveoli of the temporary teeth, the bone being exfoliated and thrown off together with the teeth which it supports.

The symptoms of periostitis of the jaw resemble in an aggravated form those attending the dental disease. There are violent pain and great swelling, and œdema accompanied by fever. The occurrence of suppuration

is marked by rigors, and is often attended with increase rather than diminution of pain, unless the matter find immediate vent. The skin assumes a shining, erysipelatous aspect, and pits on pressure, and after a time the abscesses point and discharge pus through openings corresponding to the position of the diseased bone, to which they lead by fistulous passages. These openings are similar to those described as occurring in alveolar abscess discharging through the cheek. When necrosis has supervened the rough denuded surface of bone can be felt by probing.

In exanthematous necrosis the symptoms commence in the gum, which, with the periosteum, ulcerates and lays bare the bone. It is accompanied by a discharge of fetid pus. It gives rise to little or no pain.

The treatment of periostitis of the jaw consists of local bleeding by means of leeches, and free incisions through the gum down to the bone, with assiduous application of warm fomentations. All sources of irritation, such as hopelessly decayed and necrosed teeth, must be removed. As soon as matter forms it must be evacuated by the bistoury. The general health will of course receive due attention.

When necrosis has supervened the treatment is directed to maintaining a free vent for the discharges, destroying their fetor by antiseptic lotions, and removing the dead bone. In exanthematous necrosis the amelioration of the general health is the first care, locally detergent lotions are called for, but incisions or bleeding are not required.

Detergent lotions may be composed of carbolic acid, two grains to the ounce of water, or of Condy's fluid, half a drachm to the ounce; and it is a good plan not

only to wash the mouth frequently with these fluids, but also to inject them by means of a syringe into the sinuses when these exist.

No attempt should be made to remove the dead bone until it has become detached from the living tissue, which event may not occur for many weeks or months, and will be known by the mobility of the sequestrum on examination. It is especially important that force should not be applied in extracting the dead bone in the case of children, lest the rudimentary permanent teeth lying within the jaw be injured or removed in the operation.

By the time the sequestrum has become detached the orifices of the sinuses have usually become so enlarged as to allow the mass to be readily withdrawn by means of a pair of sequestrum forceps, but in some cases a few touches of the scalpel may be required to complete the operation. To avoid subsequent disfigurement the necessary incisions should be confined to within the mouth.

Dental exostoses consist of an outgrowth of osseous tissue from the surface of the cement, and takes the form either of prominent rounded nodules or of smooth and regular masses connected with a large portion of the root. These outgrowths are in most cases situated towards the apex of the root. The new tissue is similar in structure to ordinary cement, but when developed in a considerable quantity it is frequently penetrated by vascular canals, which, proceeding from the exterior, give off branches throughout the mass.

The cause of exostosis is chronic periostitis. In this disease — as we have seen — the periosteum becomes

thickened and vascular, and coated with masses of lymph. If the inflammation continue the lymph becomes organized into fibrous tissue, which, under favorable circumstances, undergoes ossification. The ossification commences upon the surface of the root, and proceeds outwards, the soft tissues becoming dense and almost cartilaginous in texture prior to impregnation with earthy matter. It happens occasionally that roots of adjacent teeth become surrounded and united by the same inflammatory exudation, and when this exudation becomes subsequently organized and ossified organic union of the teeth is brought about. Adjacent lower molars thus united are shown in Fig. 77 in a later page. The symptoms of dental exostosis are almost identical with those of periostitis, and it is often difficult to distinguish between the two diseases. Exostosis may, however, exist without any distinct symptoms being apparent, except, perhaps, slight congestion of the gum around the tooth; and teeth the seat of hypertrophy of the cement, although they may be the seat of no pain, sometimes give rise to facial neuralgia.

The only available treatment is extraction, an operation which must be performed when the tooth is the seat of severe or persistent pain, or is in any way a source of constant annoyance to the patient.

Necrosis.—The teeth derive their vitality from two sources,—the central pulp and the periosteum. When from any cause the pulp has been destroyed and the cementum denuded of periosteum complete necrosis of the tooth results, and it is reduced to the condition of a foreign body. Complete necrosis of this kind is occasionally met with, but cases are much more common in

which the necrosis is only partial. The pulp may be destroyed, whilst the connection of the cementum with the periosteum remains intact; or the pulp may retain its vitality, whilst the cementum has to a greater or less extent lost its connection with the periosteum.

A tooth entirely necrosed becomes speedily loosened and cast off, but if the necrosis affect a small portion only of the cementum, the tooth—whether the pulp be living or not—may remain useful for an indefinite time without giving rise to important pain or irritation.

The causes, symptoms, and treatment of gangrene of the pulp have been described in a previous section.

The most frequent cause of necrosis of the cement is periostitis. It is sometimes due to absorption of the gums and alveoli, and it may arise, especially in the case of the front teeth, from an injury, such as a blow, which has partly dislocated the tooth and severed at once its vascular connections.

Necrosis of the cement manifests itself by suppuration, the amount varying, of course, with the extent of the disease. The matter escapes through a fistulous opening in the gum or wells up around the root from within the alveolus.

The surface of necrosed roots is rough and discolored. The roughness is due to the denudation of the periosteum and to absorption, which almost always affects to some extent the necrosed cement. In cases where the periosteum is entirely detached a thin probe can be passed along the root within the alveolus to near the apex. Roots in this condition exposed to the access of saliva become coated with tartar or studded with small nodules, and the deposit is usually of the hard black variety.

The sole treatment of necrosis of the cement is extraction, but the operation is, of course, not called for so long as the tooth remains useful and free from severe pain.

Absorption of the roots of permanent teeth is a common accompaniment of chronic periostitis and of necrosis. If the roots, especially the apices, of teeth affected with these diseases be examined after extraction it will be found that they often display patches of roughened excavated surface closely resembling that presented by bone and by the roots of temporary teeth when undergoing absorption. Although several are recorded, cases of complete or even of considerable absorption of the roots of permanent teeth are rare—no doubt, because the teeth are usually lost before the process is far advanced. The disease, when extensive, manifests itself by loosening of the tooth. Extraction is the sole treatment.

Absorption of the alveoli, sometimes described as a distinct disease, occurs in the vast majority of cases merely as a consequence of chronic dental periostitis, and calls for similar treatment. The same treatment can be alone applied in those cases of obscure origin in which the teeth are lost in middle life by a gradual wasting of the sockets, closely resembling that which takes place as a natural process in advanced age.

DISEASES OF THE GUMS AND ORAL MUCOUS MEMBRANE.

Inflammation of the gums may be due to various causes. Some amount always accompanies dental periostitis; it may arise from the irritation of tartar accumulated around the necks of the teeth, or from the presence of necrosed teeth and roots; it may be associated with disorders of the digestive organs, especially such as occur in pregnancy and gouty subjects, and in those who habitually take alcohol to excess. It is also often caused by constitutional syphilis, it forms a prominent symptom in ptyalism and in chronic mercurialization, and it is present in diseases which, like scurvy, are due to a depraved state of the blood.

The inflammation may involve a small part only of the gum, or may attack the whole surface in each jaw. The limited variety is most commonly occasioned by local irritation; general inflammation of the gums generally arises from constitutional disorder.

Symptoms.—The gums are deep red or purple in color, swollen, spongy, and tender, and they bleed on the slightest touch. Pus oozes, or can be squeezed from around the teeth at the free edge of the gum, where ulceration often also occurs. If the disease continue for any length of time, it always spreads to the dental periosteum, rendering the teeth loose and tender, and leading to absorption of the alveoli. Chronic inflammation sometimes leads to hypertrophy of the gum. The out-

growth is at first soft, but after the lapse of time may become hard and fibrous in character.

The treatment must be first directed to the removal of the exciting cause, and all sources of local irritation must be done away with, tartar and hopelessly loose and necrosed teeth being at once removed. The gums may be unloaded by free scarification, followed by warm fomentation, in the acute stage, and by astringents, such as tannin, in the chronic form. Where a fetid discharge exists detergent lotions may be prescribed, and the neck of the teeth may be swabbed with solutions of chloride of zinc or carbolic acid. Where the inflammation is associated with constitutional disorder local treatment is of secondary importance, and the remedies must be applied to the amelioration of the general health.

Thrush is an inflammation of the mouth occurring in infants. The entire mucous membrane is reddened and studded at parts with vesicles, especially inside the lips and on the tip of the tongue. These vesicles give place to patches of exudation, which are thrown off, leaving the membrane exposed and deeply red in color beneath. With these symptoms there is fever and often diarrhœa. The treatment must be directed to the general health. Locally, soothing applications, such as lotions of glycerin or borax and honey, are most useful.

Aphthous, or follicular ulceration, occurs both in adults and in children. The first stage of the malady takes the form of simple inflammation of the mucous membrane. In the next stage, small, round, transparent vesicles appear, which burst, leaving small spreading ulcers with red and swollen margins. Both in this disease and in thrush, in some cases, the ulcers become coated with a layer of a microscopical parasite (oidium

albicans). Besides constitutional treatment, which is of the first importance in this affection, the ulcers may be touched with sulphate of copper or nitrate of silver, and a lotion may be prescribed to destroy the vegetable parasite, composed of sulphate of soda, ℥j to ℥j.

Ulcers of the tongue and lips often originate from friction against the ragged edges of broken and decayed teeth, and ulcers in these situations arising from other causes—such as syphilis and dyspepsia—are frequently aggravated by similar irritation. Ulcers due to irritation of ragged teeth vary in size with the length of time they have existed, and they may attain large dimensions. They are of irregular form, with slightly hardened bases, and are situated as a rule on the surface of the mucous membrane lying against the faulty tooth, those on the tongue appearing on the side and under surface. These ulcers, when neglected, may assume an aspect closely simulating epithelioma, and the resemblance is rendered more complete in some cases by the induration of the glands beneath the jaw which accompanies them.

In all cases of ulcers in the neighborhood of decayed teeth, it is desirable to file down and polish the rough and ragged surfaces. Should the ulcer be of a simple character it will then soon heal. The cure may be hastened by the use of astringent lotions, such as nitrate of silver, two grains to the ounce of water.

One of the commonest symptoms of constitutional syphilis is the occurrence of ulceration of the mucous membrane of the mouth, which assumes various forms, sometimes not easily distinguishable in appearance from the varieties above described, due to other causes. Such cases can be diagnosed by the presence of other symp-

toms indicative of syphilis, and by their obstinacy under any but specific treatment.

Cancrum Oris.—This comparatively rare disease is confined entirely to young ill-fed children inhabiting low crowded neighborhoods. The disease may be well defined as sloughing phagedæna of the gums and cheeks. It may begin at any part of the mucous membrane, but in many cases makes its appearance at the edge of the gum about the necks of the central incisors, in the form of a yellowish or ash-colored ulcer. Thence it spreads with great rapidity, and speedily attacks the inside of the cheek, which is, however, often swollen, and the seat of ulceration from the first. The ulceration extends in the direction of the sockets of the teeth, destroying the gums and periosteum, and causing necrosis of the teeth and bone. The affected soft parts slough, and a large ragged ulcer of a dirty blackish appearance is formed, which perforates the cheek. A profuse discharge of fetid purulent fluid and saliva accompanies the progress of the ulceration. In the early stages, and until sloughing has commenced, there is little or no pain. The disease often ends fatally, the patient dying from exhaustion.

The treatment consists in supporting the patient's strength by nourishment, together with quinine, ammonia, and brandy. Locally, the sloughing surface must be destroyed by nitric acid, or acid nitrate of mercury, whilst detergent lotions are employed to destroy the fetor of the discharges.

ABRASION OF THE TEETH—MECHANICAL INJURIES.

As age advances the teeth become ground down by mastication. The enamel is first worn off, next the dentine suffers, and in time the pulp would be laid bare were it not that it almost invariably undergoes calcification on the surface *pari passu* with the slow destruction of the hard tissues. The amount of abrasion in every case depends of course on the density of the teeth, and on the kind of usage to which they are subjected, and to some extent on the bite—the manner in which the teeth articulate. If the bite be normal, abrasion of the front teeth becomes rarely excessive, but if these teeth meet edge to edge they are worn down, sometimes even to the level of the gum. In rare cases, from some unexplained cause, the front teeth are ground down more rapidly than the molars, so that after a time, on closure of the mouth, the incisors of the opposing jaws cannot be brought into contact. Abrasion of the teeth of this slow kind is in most instances unattended with suffering, but it is occasionally accompanied by tenderness or pain due to exposure of sensitive dentine, or to approaching exposure of the pulp.

The treatment of abrasion of this kind is the same as that prescribed in a previous section for sensitive dentine and irritated pulp.

Transverse grooves or slits sometimes met with on the labial aspects of teeth can be traced in most cases to the

use of hard toothbrushes and gritty toothpowders. They are most frequently found on the surfaces of teeth, which owing to their position or prominence are most exposed to the friction. The exposed surface often becomes extremely sensitive. The treatment is the same as for ordinary abrasion, but where the groove is of great depth it is often good practice to reduce the walls to a suitable shape, or cut retaining-points and put in a permanent filling.

Fracture of the teeth may arise from injury, such as a blow upon the mouth, or may occur during mastication, as when a fragment of bone, a small gritty particle, or a shot in game is bitten upon. If the fracture, however caused, do not lay open the pulp-cavity it will often suffice to file down the rough surface, and carefully polish it. In other cases, if the fractured surface is of such a shape as to form a cavity, or so situated that it appears desirable, a filling may be inserted. If the pulp be exposed by the injury, and the fracture extend in a vertical direction into the root, the extraction of the tooth will be called for, but if the fracture involves only the crown an attempt may be made to save the tooth, or at least the root. The pulp in most cases must be at once destroyed, after which fang-filling may be performed; or should the tooth be an incisor or canine, an artificial crown may be attached to the root in the manner elsewhere described.

Dislocation of the teeth, and more particularly front teeth, is not an uncommon effect of blows upon the mouth. Sometimes the tooth is only started from the socket or partly dislocated; sometimes it is completely dislodged.

Treatment.—If partly dislocated the tooth must be pushed back into the socket. In complete dislocation,

if the case be seen within a few hours, the tooth may be replanted in the socket. The socket should be first washed out with syringe and warm water, to clear it of coagulated blood, and the tooth having been also cleansed, should be replaced in the socket. If but a short time has elapsed after the tooth was knocked out, if great care be taken to support the tooth by ligatures and to guard it from injury, it will in favorable cases regain its attachment to the socket, and may remain firm for years. Upon this treatment, as well as upon partial dislocation, there may supervene an attack of acute periostitis, which must be treated in the manner described on another page.

SALIVARY CALCULUS OR TARTAR.

Saliva, among its other constituents, holds in solution a small proportion of earthy salts, and these salts are very liable to be deposited upon the teeth in the form of a concretion—salivary calculus or tartar. There are indeed few mouths, however healthy, which are absolutely free from deposits of tartar, whilst in some individuals with disordered health, and with local conditions favorable to the formation, it accumulates in enormous quantities.

Diseases associated with disorders of the digestive organs and with vitiation of the secretions of the mouth predispose to the formation of tartar. It is deposited upon teeth which are not subject to the friction of mastication, and it is common to see the teeth of one side of the jaw covered by the concretion when the presence of tender teeth compels the patient to use the other side alone. It accumulates often in great masses around teeth the alveoli of which are undergoing absorption. The accumulation is always greatest upon the external labial surfaces of the upper molars and on the lingual aspects of the lower front teeth, owing to the proximity of these surfaces to the orifices of the salivary ducts.

The density and color of tartar vary considerably. When rapidly deposited it is soft and friable, and light yellow in color; when slowly formed it is hard and darker in color—brown, greenish, or even quite black.

Analysis of tartar shows its composition to be as follows:

Earthy phosphates,	79.0
Salivary mucus,	12.5
Ptyalin,	1.0
Animal matter,	7.5

According to Tomes, salivary calculus differs somewhat in chemical composition according to the situation in the mouth where it is deposited. Thus that formed near Stenon's duct contains most carbonate of lime, whilst in that deposited on the lower incisors phosphate of lime preponderates.

Microscopical examination shows that the animal matter entering into the formation of tartar is largely made up of epithelium, whilst numerous filaments of leptothrix are always present in the mass.

The peculiar green discoloration occurring upon the teeth of children, and most frequently affecting the labial surfaces of the front teeth, appears to be due to staining of Nasmyth's membrane and deposit of leptothrix.

Deposition of tartar occasionally begins around the necks of the teeth beneath the free edge of the gum, and, acting as a foreign body, it keeps up chronic inflammation of the gums and periosteum, and thus constitutes in numerous instances the sole cause of absorption of both gums and alveoli.

Treatment.—Careful use of the toothbrush and due exercise of the teeth in mastication will do much to retard and prevent the deposition of tartar, but where these measures fail the deposit, if of great extent, must be removed by suitable scaling instruments. The blade

of an instrument should be inserted beneath the edge of the tartar around each tooth below the gum, and levered outwards. By this means it is possible in many cases to detach the concretion in scaly masses, leaving the enamel smooth and intact beneath. Flat thin-bladed instruments are required to pass between the teeth and dislodge the deposit which occupies the interstices. In some cases, being densely hard and adhering with great tenacity, the tartar can be removed only by gradual scraping. Superficial discoloration—such as occurs in children—is best removed by pumice powder, with water, and a wooden or cane point.

In the operation of scaling it is of the utmost importance that every particle of tartar be removed, and that the enamel be left perfectly smooth, since a rough surface favors rapid redeposition. The teeth, when necessary, can be polished after the operation by pumice powder, followed by chalk or slate stone.

MORBID GROWTHS CONNECTED WITH THE TEETH.

Odontomes.—Under this name there have been classed and described during late years several varieties of malformed and monstrous teeth and tumors composed of confused masses of dental tissues. The etiology of these morbid products has not yet been clearly made out. It appears, however, certain that they can originate only during the development of the teeth. At this period (as we have seen) the teeth are represented by soft tissues, which gradually assume the form of the future organs, and become calcified. During this stage of growth the formative elements may become the seat of partial or general hypertrophy, or atrophy, or other morbid action, followed by more or less complete calcification. The morbid process may be confined to the enamel organ, or to the dentine pulp, or may involve all the tissues of the tooth. The most simple form of these morbid growths is displayed in what have been called warty teeth—teeth which present nodules or excrescences projecting from some part of the surface. The excrescences most frequently spring from the neck of the tooth below the gum, and occasionally they assume the appearance of a supernumerary tooth lying in contact with the tooth to which they are attached. Section of these outgrowths shows them to be composed of dentine coated with enamel, and they sometimes contain a pulp-cavity continuous with that of the tooth. The roots of warty

teeth are often well formed, but in some cases, especially where numerous excrescences exist on the crown, the root is stunted and ill-formed. In these cases, along with hypertrophy of the tissues of the crown there appears to have occurred arrest of development of the root.

On the other hand, cases sometimes occur in which the crown of the tooth is normal in form, whilst the root is abnormally large, and is composed of a confused mass of dentine and osseous tissue (cement), inclosing a vascular structure, doubtless the hypertrophied dentinal pulp.

Another class of odontome consists of irregular masses of dental tissues mingled without definite arrangement, and bearing no resemblance to a tooth. The mass may not exceed in bulk the tooth whose place it occupies, or it may form a tumor of considerable size.

Still another variety of tumor having the same origin as those just mentioned is mainly fibrous in structure, containing scattered spots of calcification or imperfectly developed dental tissues. These tumors are usually encysted, having no attachment to the surrounding structures except such as may have arisen from inflammatory adhesion.

Odontomes do not necessarily give rise to irritation or disease, and the variety in which the morbid changes are confined to the root may, on the contrary, remain in position for years, serving the purpose of a tooth. Should they, however, constitute a deformity, become a source of irritation, or the centre of inflammatory action, they must be removed. Their extraction can be accomplished in some cases by means of an ordinary tooth-forceps, and, should it be necessary, the bone may be

divided by the bone-forceps to facilitate the operation. The fibrous variety may be removed by similar means. The cyst having been laid open, the mass may be turned out with the handle of a strong scalpel. It may be here remarked that in all cases of tumor of the jaw of doubtful diagnosis exploratory incisions—within the mouth if possible—ought to be made to ascertain the true character of the disease, before a formidable operation like excision of the jaw is proposed. An operation of this magnitude and severity was not infrequently performed for the removal of odontomes in former times before the real nature of these growths was recognized.

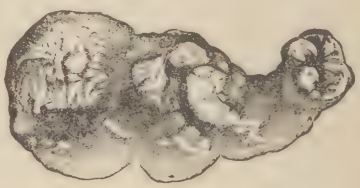
FIG. 52.

Fig. 52, from Mr. Salter's work (7), shows a magnified section of an odontome in the Museum of the Col-

lege of Surgeons, of which the natural size is displayed in Fig. 53. The crown of the tooth, a molar, is normal in size, but the root is enlarged into a mass more than twice the size of the tooth. The outer layer of this

FIG. 53.

FIG. 54.



mass is composed of cementum, within this is a layer of dentine, whilst the centre is composed of "a confused mass of bone structure and dentine structure arranged around and separating an elaborate vascular network of the same character as that of the dentinal pulp."

Fig. 54, from the Transactions of the Odontological Society, vol. iii, exhibits an odontome (natural size) removed by Mr. Hare, of Limerick, from the upper jaw of a man. The growth occupied the position of the antrum, in which situation pain had long existed and where suppuration had occurred, leading to the formation of a fistulous opening through the cheek. Its structure is identical in its main features with that of the specimen in the College of Surgeons' Museum.

The engraving (Fig. 55) from Mr. Heath's work, exhibits an odontome occupying the left side of the lower jaw. The following is a summary of the account of this tumor as given by Mr. Heath: The patient, a man aged twenty, had suffered with disease of the lower jaw

since he was five years old. Upon looking into the mouth, a round, smooth tumor, hard and unyielding, was seen occupying nearly the whole of the left side of the jaw. None of the teeth, beyond the first bicuspid,

Fig. 55.

were present. The portion of jaw shown in the engraving was removed by operation by M. Forget, under whose care the case came. Examination of this portion showed that the jaw between the first bicuspid and the ramus was converted into a cavity which was occupied by a hard oval mass, of the size of an egg, having an uneven surface covered here and there with minute tubercles, which were invested by a layer of enamel penetrating into the substance of the bone. Section and microscopical examination showed the tumor to consist of dentine with enamel on the surface and dipping into the crevices, at the bottom of which as well as in other parts portions of cementum were found. Between the tumor and osseous cyst inclosing it was a thick mem-

brane of a fibro-cellular structure. Dr. Forget regarded the case as one of fusion and hypertrophy of the last two molars.

At the date of the occurrence of this tumor (1855) the exact nature of growths of this kind had not been clearly ascertained, and hence excision of a portion of the jaw was performed, instead of enucleation of the tumor, which evidently would have served equally well for the cure of the disease.

The letters *a* and *b* indicate portions of the tumor projecting through the bone; at *c*, where the inclosing bone is cut away, the crown of an inverted molar is seen lying between the tumor and the jaw; *d* is the second bicuspid lying beneath the first, *e*.

Cysts of the jaw may be either simple or dentigerous, that is, containing one or more complete or rudimentary teeth. They may occur in either jaw, and are usually situated towards the posterior part of the bone. They are more common in the young than in the aged.

Cysts commence as a gradual painless enlargement of the bone, and may in time attain a great size. Sometimes they inflame and suppurate. On manipulation in some cases the expanded walls of the cyst yield to pressure, and give beneath the fingers a stiff parchment-like crackling; but in other instances they are so hard as to resemble solid growths. When the tumor is punctured a serous fluid escapes. The course and symptoms of simple and dentigerous cysts are alike, and it is often impossible to distinguish between them except by exploratory incisions. Dentigerous cysts, however, generally occur during childhood, often commencing at the period of second dentition, and when teeth are missing from their position after the time they should appear, a

clew to the nature of the case is afforded. These cysts are almost always connected with permanent teeth, but they may contain temporary or supernumerary teeth. In most cases the cyst contains only a single tooth, but instances are recorded in which many supernumerary teeth have been found in one tumor. Cysts of the jaw may contain only one cavity, or may be multilocular—that is, made up of several small cells separated by osseous or fibrous walls. The etiology of simple cysts is not clear, but there is evidence that they may in some cases be caused by dental disease. It has been before mentioned that in ordinary alveolar abscess the bone often expands and incloses the accumulating pus, and it is easy to perceive how such a cyst might attain a considerable size, and might commence to secrete serous fluid, and still progress after the suppurative process was arrested.

The origin of dentigerous cysts is more evident. Each developing tooth at one stage of its progress is inclosed in a complete bony cyst, and it is not difficult to understand that if the eruption of the tooth be prevented, and from any cause fluid be slowly poured out within the cavity, the bony walls gradually expand and a tumor is formed. Mr. Tomes has pointed out that when the developing crown of a tooth is completed a small quantity of fluid is to be found between the surface of the enamel and the investing soft tissue, and he believes that it is the gradual secretion and collection of this fluid in abnormal quantity which causes expansion of the bone.

The treatment of cysts of the jaw consists in laying them open freely, in removing teeth when these are contained within, and plugging the cavity with lint, so as to set up suppuration and destroy the secreting surface.

The incisions ought to be made within the mouth when possible, so as to avoid subsequent deformity.

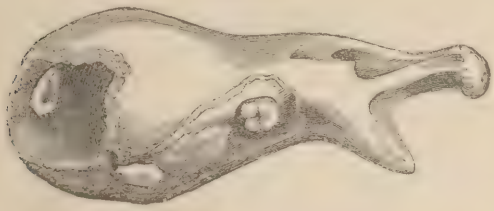
The following case with the illustration taken from Mr. Heath's work (9), will serve to exemplify the common course and history of dentigerous cysts, and also to make evident the importance of the rule already mentioned, that in cases of doubtful diagnosis the nature of tumors of the jaws should be ascertained by incisions and explorations before further operative procedures are undertaken.

In this case the cyst occurred in the lower jaw, and gave rise to a general expansion of the bone rather than a distinct tumor, and the disease was mistaken for a solid tumor of the lower jaw. The patient was a girl aged thirteen. The tumor was large and resistant, and occupied the left side of the lower jaw, and had been growing six months. No opening could be detected in the tumor, though there was a constant offensive discharge from the surface. The surgeon in charge of the case removed the left half of the jaw, from the symphysis to the articulation. "The tumor (Fig. 56) gave exit to a quantity of fetid pus on being opened, and it proved to be a bony cyst formed by the expansion of the two plates of the jaw. The cavity was lined with a thick vascular membrane, and at the bottom the canine tooth was seen projecting from the wall. The case was evidently, therefore, one of dentigerous cyst due to the non-development of the canine tooth, the contents of which had from some cause become purulent."

Epulis is a fibro-plastic or fibrous tumor attached to and springing from the maxillary periosteum. It generally commences between two teeth, which become gradually pushed apart and loosened; but it sometimes springs

from a part of the bone distant from the teeth. It grows slowly and painlessly, forming a firm, rounded, often lobulated mass, covered with mucous membrane. A case

Fig. 56.



of epulis in its simplest form is shown in Fig. 57, from Mr. Heath's work. It sometimes reaches an enormous

Fig. 57.

size, encroaches upon the cavities of the nose and eye, and produces great deformity. In the latter stages it may ulcerate, and frequent hæmorrhages taking place, the growth closely simulates malignant disease. Epulis is believed to be due in some cases to the irritation of decayed teeth or to injuries of the alveoli, such as sometimes occur in extracting teeth, but in most instances the tumor cannot be clearly traced to these causes. The treatment consists in cutting out the tumor, together with the portion of bone from which it springs, and from

which, if allowed to remain, it would probably again grow.

Osseous tumors, or exostoses of the jaws, are occasionally met with. The most common situation of exostoses is on the inside of the lower jaw, where they form hard, round, smooth protuberances. They sometimes spring from the angle, and they may also grow from the neighborhood of the antrum and other parts of the upper jaw. Osseous tumors are slow in growth and painless, and are not commonly developed to such an extent as to cause inconvenience. Their cause is obscure, but in some few cases they would appear to be associated with persistent irritation spreading from the teeth. There is evidence that these tumors are sometimes due to ossification of growths originally cartilaginous in structure.

The treatment is excision of the tumor, which may be called for if the growth becomes a source of deformity or inconvenience.

DISEASES OF THE ANTRUM.

Inflammation of the antrum is by no means common. It arises sometimes from injury, or from the presence of a foreign body, such as a tooth-fang which has been pushed into the cavity in an attempted extraction, but it is more commonly caused by the irritation of decayed teeth—molars and bicuspids—the roots of which either enter or approach closely the floor of the cavity. The symptoms are acute throbbing pain, with great swelling of the cheek, accompanied by more or less feverishness. If the disease run on, the pain becomes more severe, extending to the nose and frontal sinus, and an erysipelatous blush appears on the skin. The gums are red, spongy, and swollen, and sometimes there is a discharge of pus from the nostril of the affected side. The formation of pus is attended by rigors. If the matter find vent, the pain and other symptoms may subside; but if it do not find an exit the symptoms persist, and the walls of the antrum become distended, and encroaching upon the neighboring cavities occasion pressure upon the contents of the orbit, with protrusion of the eyeball, closure of the lachrymal duct, and blocking up of the nostril.

Inflammation of the antrum, except in its severest symptoms, resembles some cases of dental periostitis, and it is indeed often merely an extension of that disease to the contiguous lining membrane of the cavity.

Treatment.—Foreign bodies are best removed by opening the cavity freely and syringing with warm water. The exciting cause must be removed, whether it be a

root lodged within, or a decayed tooth in the neighborhood of the cavity. The extraction of the tooth will often be followed by subsidence of the symptoms, the matter, if suppuration have occurred, escaping through the alveolus. If the antrum remain distended, the matter not freely escaping, the opening may be enlarged by pushing a trocar through the bone in the apex of the alveolus, or an opening may be made through the external wall of the cavity. This operation must be followed by warm fomentations and the injection of warm water into the cavity. If the discharge continue after subsidence of the acute symptoms, lotions of nitrate of silver or chloride of zinc may be thrown into the cavity.

Dropsy.—When the natural outlet of the antrum becomes from any cause obstructed, an accumulation of fluid may take place, causing gradual distension of the walls of the cavity, and giving rise to considerable deformity. The disease is usually slow in progress, and unattended with pain. A puncture with an exploring needle, or an incision, will establish the diagnosis where doubt exists.

Treatment.—A free vent for the fluid having been afforded by one of the methods already mentioned, the cavity must be frequently injected with a lotion composed of chloride of zinc, 3 grains to the ounce of water; nitrate of silver, 2 grains to the ounce; or tincture of iodine, 1 drachm to the ounce.

The antrum is sometimes the seat of dentigerous cystic, fibrous, and other tumors, which call for no special observations here, after the general remarks upon morbid growths of the maxillæ which have been made in a previous section.

PIVOTING TEETH.

After the partial or complete destruction of the crown of a tooth by injury or disease, it is possible in many cases to attach permanently an artificial crown to the root by means of a peg or pivot fixed in the pulp-canal—the pulp having been, of course, previously removed. The incisors and canines are, as a rule, alone suitable for this operation, but it may occasionally be practiced successfully upon the bicuspids. The root should be free from disease. If periostitis exist, it must be treated, and even in cases where no symptoms are apparent, it is good practice to dress the canal with carbolic acid, and to plug it for a few days before permanently closing it by the pivot. An attack of acute periostitis will often follow the operation if this precaution be not observed.

In preparing the tooth the remaining portion of the crown must be excised. This is accomplished by means of a small saw, cutting forceps, and suitable files. The edge of the root must be reduced to the level of the gum, and its surface should be concave. The depth of the canal having been ascertained by probing, it must be reduced to an equal calibre throughout, to near the apex. The most suitable calibre for the canal is one that will admit a wire of ordinary dental pin size. It often happens, however, that the canal has been already enlarged to a greater size by decay, and in such cases the softened tissue must be cut away, and the walls of

the cavity rendered smooth. The canal will remain in these cases tapering in form.

A model of the part should then be taken by the following method. A wooden pin is cut to fit the canal and long enough to project slightly beyond the orifice when inserted. With the peg in place an impression of the root and adjacent teeth is taken in the usual way (plaster of Paris is preferable for the purpose), and in this the pin comes away. The cast which is prepared from the impression shows, on withdrawal of the peg, the size and diameter of the canal, and an artificial crown can be fitted to the root and attached to a pin in the patient's absence. In the case of bicuspids, it is sometimes a good plan to fill one division of the bifid pulp-cavity with gold and attach the new crown by a single pin. Sometimes a split pin or two pins may be used.

The material of which the pivot is made will depend on the size of the canal. If it be small, metal—gold or platinum—answers best, if large, a piece of compressed hickory is more suitable, or perhaps better, a metal pin may be screwed into the wood which can be filed down to the desired size.

If wire alone, the pin should fit the canal accurately, but not tightly. It should be roughened by the file and covered with a thin even layer of floss silk. The canal having been thoroughly dried, the silk should be saturated with solution of gum copal in ether or mastic in spirit, and the pivot tooth may be then pushed firmly into place.

If a wooden or a wood-coated pin be used, the procedure is the same, save that no cement or silk is used. The pin should fit the canal so tightly as to require

a moderate amount of force to drive it home. When there the moisture of the mouth causes the wood to expand, and binds it with great firmness in position.

Pivot teeth should be so arranged as to escape contact with the teeth of the opposing jaw during mastication. Where the bite is close, a flat tooth mounted on a plate covering the surface of the root is most suitable; where the bite is free, a tube tooth may be employed.

NEURALGIA AND DISEASES OF THE NERVOUS SYSTEM.

Facial Neuralgia.—The fact is well known that irritation of a nerve commonly manifests itself by pain at some point distant from, instead of at the seat of injury or disease. This phenomenon cannot be accounted for, yet nevertheless presents itself daily to clinical observation, and may be exemplified by the case of an inflamed liver giving rise to pain about the right shoulder, a diseased hip-joint producing pain at the knee, and an irritated tooth-pulp exciting pain at remote parts of the head and face. Pain of this reflected or sympathetic character is called neuralgia. Neuralgia, or nerve pain in a part may also occur without the existence of a lesion of any kind. It may be caused by debility, by cold, or by malaria, or it may accompany pregnancy. It may be due to disease of the great nerve centres, the brain or spinal cord. Finally lesions of nerves not necessarily painful may give rise to neuralgia in consequence of disorder of the general health—thus cases are met with frequently in which the diseased nerves of carious teeth, previously the seat of little or no pain, give rise to severe neuralgia when the patient has become lowered by disease or by exhaustion.

Neuralgic pain is usually of a plunging, lancinating, or burning character, following the course of the nerve branches. It occurs in paroxysms, which are often regularly periodic, the pain commencing at a particular hour

of the day, lasting a certain period and then disappearing completely for a time.

The pathology of neuralgia has not yet been clearly made out, and the causation of the disease is often extremely obscure. When we remember the physiological fact mentioned at the opening of this section, and consider that the fifth nerve which supplies the teeth is distributed also to nearly the whole of the head and face, it is at least not difficult to understand that diseases of the teeth may act as frequent exciting causes of facial neuralgia. And since, as is pretty generally acknowledged, there are no symptoms which serve to distinguish neuralgia due to constitutional causes from that set up entirely by local disease, it is impossible to overrate the importance of searching for lesions of the nerve in all cases in which doubt exists.

Any of the pathological conditions of the teeth which have been described in preceding sections are capable of giving rise to neuralgic pain, but among them all chronic inflammation of the pulp is the most frequent cause. In every case of facial neuralgia a careful examination of the teeth should be made. It is not sufficient to take the patient's assurance that his teeth are not decayed, or that he does not suffer from toothache. Patients are often unconscious of the presence of disease, and teeth which do not ache are frequently the excitants of neuralgic pain. Neither is it sufficient to cast a glance into the mouth for carious cavities; each tooth should be separately explored with the aid of a probe and mouth mirror. Cavities hidden in the interstices or below the gum must be sought for, and the signs of necrosis, exostosis, inflammation, and thickening of the dental periosteum must not be overlooked. Decayed and broken

down wisdom teeth (common causes of neuralgia and especially of pain in the ear) are often, owing to their position, difficult to discover. They are in many instances placed at the extremity of the alveolar ridge, and in the upper jaw are invisible except with a mouth mirror; whilst in the lower jaw they are commonly hidden by folds of the cheek or by overhanging gum. Decaying in many instances before they are completely erupted, these teeth after the destruction of their crowns by caries are occasionally quite invisible, and their presence in the sockets can be ascertained only by passing a probe through the small fistulous tract in the gum which covers them. A condition similar to this may also exist in the case of any other tooth, and buried roots, especially when the seat of exostosis, are the excitants of neuralgia in numerous instances.

Although in cases of obstinate neuralgia there can be no doubt of the propriety of removing such diseased teeth as cannot be brought by treatment into a healthy state, it must be borne in mind that all decayed teeth need not be condemned to extraction. Neuralgia may be often guarded against by filling decayed cavities and protecting the sensitive structures of the teeth from irritation. In these operations care should be taken to avoid increasing the susceptibility of the teeth to changes of temperature. For this purpose the oxychloride of zinc cements answer admirably, and in cases in which the pulp is exposed or protected only by a thin layer of dentine a layer of this material should be applied to the bottom of the cavity in the manner described in a former page.

There are other surgical diseases besides those of the teeth which involve branches of the fifth nerve, and

which may therefore originate neuralgia, and in every case of doubtful diagnosis it is necessary to examine as far as possible the whole course of the nerve. The nerve, or its branches, may be compressed by tumors or aneurisms, or be affected by the inflammation, exostosis, or necrosis of the bony canals through which they pass. Inflammation of the mucous membrane of the antrum may include the superior dental nerves. One case is reported by Niemeyer in which a foreign body was imbedded in a branch of the nerve. Syphilitic nodes of the head are accompanied by pain, with nightly exacerbations of a character similar to neuralgia.

The discovery and removal of the exciting cause (as above remarked) must be the first care in dealing with neuralgia, but the treatment of the predisposing causes must not be overlooked. It has been already pointed out that the state of the general health often determines whether we have to attack slight local pain or severe neuralgia. Conversely, with improvement of the general health the pain frequently disappears, although the exciting cause may remain. If the disease has been developed by any form of debility, or by malaria, full doses of quinine give almost always excellent results, and where this drug fails Fowler's solution of arsenic is said to prove effectual. Anæmia, rheumatism, and syphilis will each receive their appropriate treatment.

In those cases (by no means unknown) in which the cause of the neuralgia, whether local, central, or constitutional, cannot be discovered, an attempt alone can be made to destroy the excitability of the painful nerves. For this purpose electricity in various forms is employed. Cold, which diminishes for a time the excitability of the nerves, may be applied to the skin by means of ice

or evaporating lotions; and ointments of aconite or veratria, or lotions of belladonna and chloroform, produce similar effects.

The division of the nerve at some point between the seat of pain and the brain, or (as section would be speedily followed by reunion) the cutting out of a portion of the nerve, is a procedure which theoretically seems likely to prove efficacious by preventing communication between the affected nerve and the brain. This operation is sometimes attempted, especially when the pain appears to have its seat in the ramifications of the mental nerve. It is, however, seldom followed by good results, and for two reasons, first, because it is difficult to pick out the nerve which is really the seat of pain, and secondly, because it is difficult to get at and divide a part of the nerve between the brain and seat of the disease which excites the neuralgia. This point is doubtless often so deeply placed that, even if discoverable, to reach it would be impossible.

Nervous Disorders.—Irritation of a peripheral nerve, besides exciting distant pain, may give rise to reflex irritation, or to functional disturbance of the brain or other great nerve-centres, resulting in various phases of morbid action; and although dental diseases no doubt rarely excite nervous affections of a nature more grave than neuralgia, yet there is abundant evidence that neuroses of the severer kind do occasionally result from irritation of the dental nerves. Reflex irritation may be transmitted both to motor and sympathetic fibres. Severe neuralgia of the face, for example, is sometimes accompanied by convulsion of the facial muscles, together with profuse flow of tears, saliva, and mucus, and perspiration on the skin at the seat of pain.

Esquirol and Ashburner relate cases in which mania and delusions accompanied difficult eruption of wisdom teeth, and were cured by incisions into the gum over these teeth. Mr. Tomes reports two cases of epilepsy consequent upon diseased teeth, the seat of exostosis, which were cured by the extraction of the teeth. Many cases of amaurosis due to diseased teeth are recorded, and these have been accounted for on the supposition that irritation of dental branches of the fifth nerve may be transmitted through the ciliary system to the retina, producing hyperæmia and inflammation.

These affections call only for the same remark which was made in regard to neuralgia—viz., that in every case of doubtful diagnosis a careful examination of the teeth should be made, with a view to the removal of every cause of nerve irritation due to dental disease.

EXTRACTION OF TEETH.

During the operation of extraction the dentist stands on the right side of the patient, who is placed low when a tooth of the under jaw is to be drawn, and raised when an upper tooth is to be removed. The instrument is held in the right hand, whilst the left hand, fingers, and arm are employed according to circumstances, in steadying the head, grasping and fixing the lower jaw, drawing back the commissure of the lips, and assisting to direct the instrument.

The instruments employed almost exclusively are forceps. These are made with blades of various patterns adapted to fit the different classes of teeth, and to grasp without crushing them. Their edges are sharp that they may be readily insinuated between the free edge of the gum and the neck of the tooth, and forced towards the socket.

The operation consists of two distinct actions, firstly, the seizure of the tooth, and secondly, the loosening of its connections, and its withdrawal from the socket.

The seizure of the teeth of each class is effected in the same manner. The forceps is lightly applied to the neck, and then forcibly pushed along the root until it becomes stopped at or within the edge of the alveolus. The grasp is then tightened, but not to such an extent as to crush the tooth, and the next step of the operation is proceeded with. As soon as the tooth is felt to yield the forceps may be pressed still deeper, so as to embrace

the tooth within the socket; to obtain more power over it, and to avoid breaking off the crown. It is not necessary to separate the gum from the neck of the tooth by means of the lancet before applying the forceps—a proceeding recommended by some authors. The connection of these parts is slight, and they are readily di-

FIG. 58.

vided by the cutting edges of the forceps. The mode of holding the forceps and applying them to the teeth is shown in Figs. 58 and 59 from Druitt.

FIG. 59.

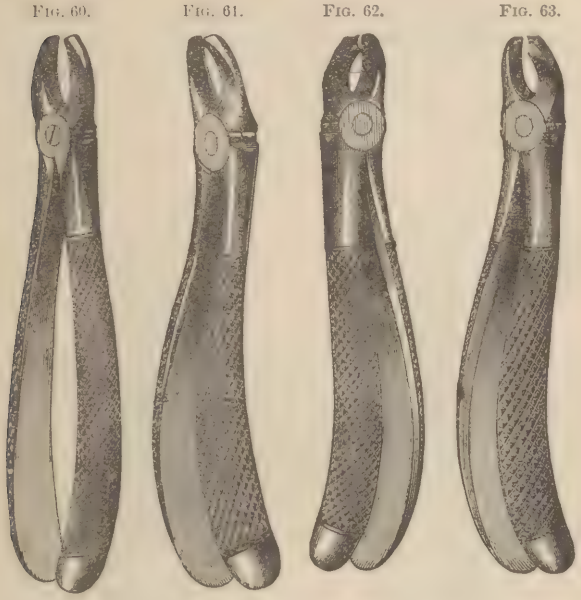
In the second stage of the operation the method of applying the force is modified with each class of tooth,

the roots varying in number, position, form, and size, and the investing bone offering less resistance in some directions than in others. This stage of the operation, although distinct from the first, is really continuous with it, the whole operation being effected with one even movement. It may be performed rapidly, by a practiced hand, but it must be remembered that an attempt to wrench a tooth from its socket by force, either wrongly directed or indiscriminately applied, will, in most cases, result in fracture of the tooth, and may also inflict severe injury upon the jaw and surrounding parts.

The forceps for the extraction of the upper incisors is shown in Fig. 60. These teeth have conical roots, and their extraction is accomplished by rotating them to the slight degree necessary to loosen them, and pulling them downwards and a little forwards. The upper canines require a stronger but similar instrument, and they are removed by the same method.

The forceps for the upper bicuspids is shown in Fig. 61. It resembles that used for the incisors and canines, but has narrower blades, and handles bent to clear the lower teeth. The upper bicuspids having roots flattened laterally cannot be rotated. They are loosened by forcing them steadily outwards. They are then moved to and fro from within outwards, and pulled downwards. Two forceps are required for the upper molars, one adapted to the teeth of the right side, one to those of the left (Figs. 62, 63). The outer blade is formed in two curves to contain the external roots, the inner blade is designed to grasp the internal root. The force in extracting these teeth is first applied in the outward direction, for the reason that the external alveolar plate offers less resistance than the inner, while the direction of the

palatine root is such that it is likely to be snapped in an attempt to move the tooth inwards. As soon as the



tooth yields it is moved from side to side, and pulled downwards.

The upper wisdom-teeth are extracted in the same way as the upper molars. The removal of these teeth, however, rarely requires great force, their roots being often connate, and the bone around being cancellated and soft. Ordinary molar forceps may be used for these teeth, but they are more conveniently reached by an instrument specially curved to pass to their position at the extremity of the jaw.

The lower incisor roots are much flattened laterally. They are loosened by bending them forwards, and completely detached by a to-and-fro movement from within outwards, combined with an upward pull. The forceps for these teeth is depicted in Fig. 64.

The lower canines, having somewhat conical roots, are loosened by a rotatory movement, and drawn by an up-

Fig. 64.

Fig. 65.

ward pull. The forceps closely resemble those used for the incisors.

The lower bicuspids, having roots flattened laterally, are extracted by forcing them outwards until they are felt to give, then moving them from side to side, and at

the same time drawing them upwards; the forceps is shown in Fig. 65.

In applying the forceps to the lower bicuspids and molars, the point of the thumb of the left hand may be placed over the joint of the instrument whilst the fingers press the jaw upwards from beneath. In this way the forceps is guided in the desired direction, enough power is obtained to drive it home, and the instrument is prevented from coming into violent contact with the upper jaw at the moment the tooth leaves the socket, whilst at the same time the danger of dislocating the jaw is guarded against. This accident has occurred in some cases.

The lower molars are loosened by force directed first in the outward direction. They are then moved to and fro from within outwards, and pulled upwards. Should the tooth offer great resistance, a backward and forward movement may be adopted, the better to free the roots, which are curved more or less in the backward direction. The forceps for these teeth is shown in Fig. 66. The lower wisdom-teeth are extracted by the same method as the first and second lower molars, than which, however, they require usually less force. A forceps is provided with the blades bent at such an angle to the shafts as permits their ready application to these teeth.

Extraction of the roots of the incisors, canines, and bicuspids, the single-fanged teeth of both the upper and lower jaws, is carried out on the principles already described—that is to say, the forceps is steadily pushed along the root, and a sufficient grip upon a sound portion obtained before an attempt is made to complete the operation. As the root yields, the thrusting of the instrument deeper may be continued, and by giving the forceps

at this time a rotary movement, the blades are made to penetrate more readily. When the root is extensively decayed or broken within the alveolus, forceps are used with smaller and more tender blades (Fig. 67), that they may be more easily passed into the socket and insinuated between the root and the surrounding bone.

Fig. 66. Fig. 67. Fig. 68.

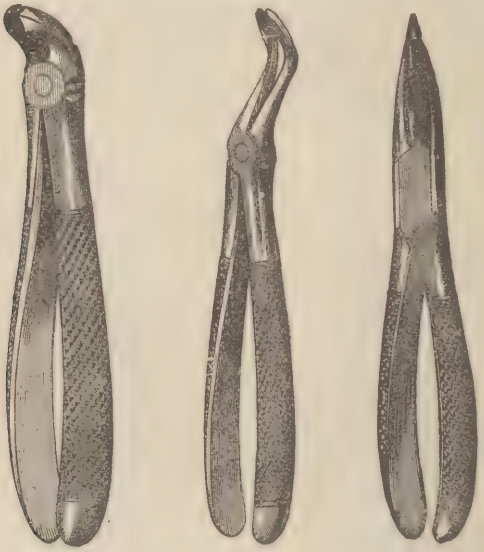


Fig. 68 represents a forceps designed for the extraction of roots of upper front teeth, which are so extensively excavated by caries as to be readily crushed by the ordinary instrument. They are provided with a screw, which is inserted into the cavity before the blades, between which the screw slides, are forced into the alveolus.

In extracting the roots of molars the procedure is guided by the extent of the decay. If the roots are still firmly united together they may be removed by the ordinary forceps, used in the manner already described. Where it appears difficult to obtain a sufficiently deep hold with the ordinary instrument, forceps specially de-

Fig. 69.

Fig. 70.

signed may be employed. These special instruments are provided with long and sharp-pointed blades, which are either thrust into the alveolus or forced through the alveolar plate. Fig. 69 shows an instrument of this kind

applied to the roots of an upper molar. Fig. 70 shows that used for the same purpose in the lower jaw.

It may be here remarked that in extracting the roots of teeth of any class, *if they cannot be seized by other means*, there need be no hesitation in including the edge of the alveolus in the forceps, or in breaking through the thin alveolar walls. If this is done with due care the operation may be rapidly performed, whilst no permanent damage is inflicted, seeing that the small portion of bone forming the thin edge of the alveolus which is injured or broken away would be under ordinary circumstances soon removed by absorption after the extraction of the root.

In those cases in which the roots of molars are detached from one another by decay, or so slightly united as to preclude the possibility of their removal in a mass, they must be extracted separately. Root-forceps (similar to those in Fig. 67) are used. They are thrust as deeply as possible into the socket. The roots of the upper teeth being conical, may be detached by a rotary movement; those of the lower, owing to their flattened shape, require a rocking movement from within outwards.

Roots which are so deeply buried in the sockets as to be with difficulty reached with the forceps may be extracted with the elevator. This instrument consists of a stout handle carrying a steel shaft, which terminates in a narrow blade. The blade is thin, and concave on its inner surface, and has either a spear-shaped or a sharp horizontal edge. Various patterns are used by different operators, but the right and left instruments depicted in Figs. 71 and 72 suffice for all ordinary purposes. In applying the elevator the blade is thrust as

far as possible into the socket along the root. The handle is then turned, so that the point of the blade impinges upon the root, and by a levering movement prizes it from the socket. In this procedure the fulcrum is necessarily formed, altogether or to a great extent, by the alveolar wall or by the adjoining tooth, and as the force exercised by the elevator is great, unless care be

Fig. 71.

Fig. 72.

taken the former may be extensively fractured or the latter dislodged. The elevator should be, therefore, firmly grasped, the fingers reaching close to the blade. The thumb and fingers of the left hand may in some instances serve partly or entirely as a fulcrum, and in every case they should be employed in guiding and supporting the instrument and controlling the force.

The elevator should not be, as a rule, inserted between the external alveolar wall and the root, this part of the bone being too thin to sustain much pressure. It should never be used for the extraction of upper wisdom teeth. The bone around these teeth is so weak as to be readily fractured by force in the direction in which it must be exerted by the elevator.

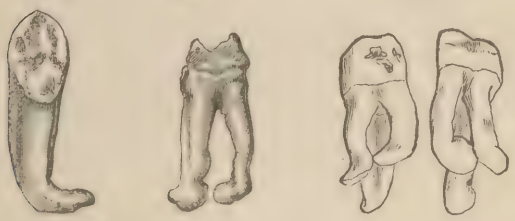
The foregoing description of the operation of extraction has been based on the supposition that the teeth to be removed were of normal character. It must be now pointed out that occasionally difficulties arise in consequence of irregular formation of the roots. Thus they may be so curved or, in the case of molars, so spread as to require more than ordinary force to remove them; indeed, the roots are sometimes so placed in the jaw that it is impossible to remove the tooth without snapping one or more of the roots or breaking away a portion of the alveolus. The portion of the alveolus most liable to be thus fractured is the septum between the roots of the molars, and especially the lower molars. The roots of these teeth, wide apart at the neck, sometimes converge towards their apices, and cannot be separated from the plate of bone which they inclose.

If unusual resistance be met with, an abnormal arrangement of the roots may be suspected. Such being the case, the operator must proceed cautiously and deliberately to exercise a sufficient amount of force to overcome the obstruction; and as it is impossible to ascertain the precise form of the irregularity, it will be found safer in applying this extra force to follow the directions given for the extraction of a normal tooth. In spite of due care it will happen sometimes that a portion of a root is left in the socket. The broken piece

is commonly loosened, and may be picked out with the root-forceps or elevator; but should the fragment, consisting only of the apex of the fang, remain fixed in its original position it may be in some cases better to leave it rather than to inflict the injury upon the bone which its withdrawal would entail. It rarely gives rise to irritation, but in due course the changes which take place in the surrounding bone lead to its loosening or extrusion. The separation of a small portion of the alveolar process during extraction is a matter of little or no importance.

Figs. 73, 74, and 75 show teeth with roots in such conditions as to give rise to unusual difficulties in their

FIG. 73. FIG. 74. FIG. 75.



extraction. The canine (Fig. 73) obviously could not be removed without either leaving the curved extremity behind in the socket or extensively breaking away the investing bone. The lower molar (Fig. 74) exemplifies the "dovetailing" of the roots of these teeth with the bone, which occasionally occurs. The presence of exostosis at the apices of the fangs of this specimen would render its removal entire hardly possible. Fig. 75 exhibits upper molars with similar irregularity of the roots, and Fig. 76 exhibits an upper molar of great

size with unusually divergent roots. The difficulties which might arise in extracting a tooth organically

Fig. 76.

Fig. 77.

united to its neighbor, as illustrated in Fig. 77, and in Fig. 17 on a previous page, are obvious.

It sometimes happens that a molar with abnormal roots of these kinds may be loosened so as to move readily from side to side, but yet cannot be drawn by any amount of force which can be safely applied. In such cases it has been recommended that the fangs of the teeth should be separated by cutting-forceps, and removed one by one. Forceps with blades fitted to be thrust into the alveolus are made for this purpose. It is often good practice to adopt a similar procedure in the removal of molars in which caries has advanced so far as completely to destroy the crown and to render the union of the roots with each other at the neck of the tooth but slight. If an attempt in these cases be made to extract the mass at once, the decayed tissues often give way, and render it difficult afterwards to grasp the broken fangs; but if the roots be first separated from each other, they may be easily removed one by one by the stump-forceps or elevator.

The Casualties of Tooth Extraction.—On this subject

Mr. Salter writes: "In estimating the casualties which may arise in extracting teeth it is well to consider the essential nature of the operations themselves. They are different from all or nearly all other surgical proceedings. In removing a tooth the operator wrenches or tears an organ from its living connection with the rest of the body, frequently by the exercise of great force. And this force is often applied with little intelligence—the operator being necessarily ignorant, from the hidden and varying nature of the parts, of many of the conditions with which he has to deal. I would not for a moment imply that the extraction of teeth does not require the application of dexterity with anatomical knowledge, but where great force has to be applied, that *per se* is adverse to mechanical delicacy. The force which the operator has to expend in removing a tooth is often very great indeed; occasionally one has to exercise the whole muscular power of the hand and forearm. It would be difficult to estimate, in measure of so many pounds, what is the force thus sometimes employed, but it must be immense; and with the exception of the reduction of dislocations of the larger joints, is probably in excess of that which is used in all other operations of surgery."

From these remarks it may be inferred that accidents in the operation of tooth extraction may occasionally happen, even in the hands of the most experienced, and therefore they must occur much more frequently in those of the unskilful.

The following list, compiled by Mr. Salter, probably includes every variety of casualty of this kind on record. Several of them have been already sufficiently referred to; others it will suffice merely to enumerate; the remainder will bear some further observations. 1. Break-

ing of tooth. 2. Breaking of jaw. 3. Taking out wrong teeth. 4. Taking out two teeth instead of one. 5. Removing capsule of growing permanent tooth in extracting its temporary predecessor. 6. Tearing gum. 7. Wounds produced by slipping of elevator. 8. Extracted tooth falling into air-passages. 9. Extracted tooth falling into pharynx and being swallowed. 10. Crushing the inferior maxillary nerve. 11. Dislocating the lower jaw. 12. Breaking one tooth in extracting another. 13. Cutting lip in removing a jagged extracted tooth. 14. Forcing tooth or tooth-fang into the antrum. 15. Forcing tooth-fang into an abscess excavation in maxilla.

Fractures involving the alveolus only to a slight extent occasionally occur, and are rarely followed by an untoward result. Fractures extending through the ramus of the lower jaw, or completely severing a considerable portion of the upper maxilla, have in rare instances been caused by the extraction of a tooth. This accident might happen either in consequence of inherent weakness of the bone or the existence of some abnormal form of the fangs of the tooth, such as already exemplified. This accident, like most of those in the above list, could be guarded against only by the application of the principles already inculcated in the general observations upon the extraction of teeth. The treatment of fractured jaw due to this cause would not differ from that arising from other forms of violence, and requires therefore no description here.

The possibility of the occurrence of the third accident has been casually alluded to in a previous section, where it was pointed out that the pain arising from an inflamed pulp sometimes becomes neuralgic in character and manifests itself in a neighboring tooth, whilst the seat of disease remains free. Patients thus frequently present

themselves and request that a certain tooth be extracted which on examination is found to be sound, or at least not the source of pain. In all cases in which doubt exists a careful inspection must be made to discover the offending tooth before an operation is attempted. The extraction of a wrong tooth in consequence of the slipping of the instrument is an inexcusable accident. Should the instrument become displaced, the operation should be stopped until it is readjusted.

The accidental extraction of two teeth instead of one may occur when force, as in using the elevator, is improperly exerted on an adjoining tooth when the latter is already loose, or when the teeth are organically united.

Some few cases are recorded in which in extracting a temporary molar, the rudimentary permanent bicuspid, which lies within the diverging fangs of that tooth, has been also brought away. In such instances adhesion between the two teeth had probably existed as a result of previous inflammatory action.

Laceration of the gum, common with the obsolete key, ought not to occur with the forceps. It sometimes happens, however, that a tooth or root has become attached to the gum by strong fibrous adhesions, which are discovered when, on loosening its bony connections, it still remains attached to the soft tissues of the jaw. In these cases, if the tooth were torn away, an extensive laceration of the gums might ensue. This is to be prevented by dividing the adhesions by a scalpel.

Several cases are reported in which, after the extraction of a lower molar, sensation was lost at that part of the face supplied by the inferior dental nerve, which had evidently received some injury in the operation. This

accident would arise from abnormal proximity of the nerve to the fang of the tooth. In most of these cases slow recovery took place.

The pain following the extraction of the tooth is rarely severe, unless periostitis exist. It is best treated by warm fomentations within the mouth. Mr. Tomes states that relief is often afforded by plugging the alveolus lightly with wool saturated with the following solution, after washing away the blood-clots; R. Acidi carbolici glacialis, liq. potassæ, āā ℥j, aquæ ℥j.

The hæmorrhage which follows the extraction of teeth in most cases is slight, and continues but for a few minutes. Occasionally, however, oozing goes on for a considerable time, whilst in rarer instances the flow is so severe as to require active measures for its arrest. The bleeding may be due to a hæmorrhagic condition of the patient, or may result from laceration of an artery. The former variety, which usually takes the form of general capillary oozing, is perhaps the more common, but the latter, in which the blood issues in a jet, or in a full florid stream, is not unknown. The vessel liable to be wounded in extracting a tooth is the dental artery, or one of its branches, which may run in abnormal proximity to the root; but it must be remembered that in consequence of periostitis which has existed for a long period, capillary vessels, previously too minute to give rise to more than trivial bleeding, may become enlarged, so as to pour out when lacerated a considerable stream. It occasionally happens that hæmorrhage, which has ceased for a time after the extraction of a tooth, recurs with severity after an interval of hours or days.

Treatment.—Slight hæmorrhage may be usually ar-

rested by cold—the mouth being freely rinsed with cold water, or better with iced water. If this do not suffice, a plug formed of matico leaf—an efficient hæmostatic in these cases—softened in hot water, may be pressed into the cavity. Should the flow persist in spite of these measures, or should it be copious or arterial in character from the first, the alveolus must be at once firmly plugged. The clots having been removed by syringing with cold water, a narrow strip of lint is taken and tightly packed into the alveolus by a blunt probe, fold upon fold, care being taken to pass it to the bottom of each division of the socket. A compress of lint is then placed in position, and pressure is kept up by causing the patient to bite forcibly upon it, and fixing the jaw by a bandage passed over the head and beneath the point of the chin. The plug—which often gives rise to considerable irritation—may be carefully withdrawn after the lapse of twenty-four to forty-eight hours.

Seeing how effectually pressure may be maintained upon the whole bleeding surface by plugging the socket in the manner described, the instances must be extremely infrequent which call for other treatment. Such cases are, however, recorded. The treatment to be adopted would consist in the application of powerful styptics and the internal administration of tincture of steel, or acetate of lead with opium, to promote coagulation of the blood. The best local styptic is perchloride of iron, and it may be applied upon strips of lint packed into the cavity. This application excites inflammation, and should therefore be used only in the severe cases in question. In cases which resist this treatment the actual cautery may be resorted to, the iron being used at

a black heat. Instances, although extremely rare, are recorded, in which every effort to arrest the hæmorrhage, including the last resource, ligature of the common carotid artery, has failed, and the patient being of hæmorrhagic diathesis has at last perished from the loss of blood.

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